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The Impact of Teachers' Approaches to Teaching and Students' Learning Styles on Students' Approaches to Learning in College Online Biology Courses

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The Impact of Teachers' Approaches to Teaching and Students' Learning Styles on Students' Approaches to Learning in College Online Biology Courses

By

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Dedication

To the loving memory of my father.

To my mother, who give me her endless love and support.

To my wife, who has supported me in all my endeavors.

To my son and daughter, who make life fun.

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The Impact of Teachers' Approaches to Teaching and Students' Learning Styles on Students' Approaches to Learning in College Online Biology Courses

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With the rapid growth of online courses in higher education institutions, research on quality of learning for online courses is needed. However, there is a notable lack of research in the cited literature providing evidence that online distance education promotes the quality of independent learning to which it aspires. Previous studies focused on academic outcomes and technology applications which do not monitor students' learning processes, such as their approaches to learning. Understanding students' learning processes and factors influencing quality of learning will provide valuable information for instructors and institutions in providing quality online courses and programs.

The purpose of this study was to identify and investigate college biology teachers' approaches to teaching and students' learning styles, and to examine the impact of approaches to teaching and learning styles on students' approaches to learning via online instruction. Data collection included eighty-seven participants from five online biology

courses at a community college in the southern area of Texas. Data analysis showed the following results. First, there were significant differences in approaches to learning among students with different learning styles. Second, there was a significant difference in students' approaches to learning between classes using different approaches to teaching. Three, the impact of learning styles on students' approaches to learning was not influenced by instructors' approaches to teaching.

Two conclusions were obtained from the results. First, individuals with the ability to perceive information abstractly might be more likely to adopt deep approaches to learning than those preferring to perceive information through concrete experience in online learning environments. Second, Teaching Approach Inventory might not be suitable to measure approaches to teaching for online biology courses due to online instructional design and technology limitations.

Based on the findings and conclusions of this study, implications for distance education and future research are described.

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CHAPTER 1: INTRODUCTION

The World Wide Web has been increasing dramatically in its popularity and accessibility due to the explosion of activities occurring on the Internet. The Internet started with 213 web servers in 1981, and expanded to over 93 million web servers by year 2000, representing an increase of 426,824 times over the last two decades (Wizard, 2000). It is estimated that there are currently over 400 million users in the world (NUA Internet Survey, 2000). The rapid growth of the World Wide Web has changed the way to create, manipulate, store, retrieve, transfer, and utilize information in our daily life (Bruce, 1998).

As society has entered the information era, there are increasing needs for life-long learning (Daniel, 1998). Although distance learning, also termed distance education, had been a successful method for decades, the creation and innovations of the World Wide Web in the 1990s revolutionized distance education (Carr, 2000). Given the popularity of the Web, no other technological phenomenon has changed the delivery of distance education more than Internet-based learning. In recent years, Internet-based courses offered through various colleges, universities, and other institutions are booming (Carr, 2000).

According to a survey of institutions of higher education conducted by the National Center for Education Statistics (NCES), 56 percent of all two-year and four-year degree-granting institutions offered distance education courses in 2000-2001, representing an estimated 2,320 institutions (U.S. Department of Education, 2003). The majority of these institutions (over 90 percent) reported that they offered Internet courses using asynchronous computer-based instruction (instructions provided through the course web

site or online courses) as a primary mode of instructional delivery. Twelve percent of all institutions indicated that they planned to start offering distance education courses in the next three years. In the 2000-2001 academic year, there were an estimated 3,077,000 enrollments in all distance education courses offered by 2- and 4-year institutions (U.S. Department of Education, 2003) compared with 1,632,350 enrollments during the 1997-1998 academic year (U.S. Department of Education, 1999). This represents a 100% increase in course enrollments from 1997 to 2000.

The evidence indicates that a transformation in the way colleges and universities deliver courses is already well underway on many campuses throughout the country. This transformation is being fueled at least in part by economic and social conditions created by a knowledgeable society that is increasingly dependent on lifelong learning. This type of environment dictates that training and education can be accessible and topical in order to serve employers who need an educated workforce both for entry-level as well as advanced employment. To respond to these societal changes, colleges and universities are increasingly concerned with expanding student access, reducing time constraints, making educational opportunities more affordable, and increasing the institutions' audiences and enrollments (Connick, 1997; Palloff & Pratt, 1999; U.S. Department of Education, 1999, 2003). Internet-based distance education is one of the methods postsecondary institutions are choosing to meet these national concerns. Colleges and universities feel compelled to establish Internet-based courses, and they are rapidly becoming a viable pedagogic tool for alternative course delivery. The question is not whether a new higher education paradigm for delivery of teaching and learning using Internet will develop, but rather, how fast it will occur and whether or not the quality of delivery will meet the needs of

learners and society. While many researchers agree that Internet-based courses provide better access and may be cost effective, they express concerns that these courses are not conducive to student success (Connick, 1997; Gibson, 1998; Harasim, Hiltz, Teles, & Turoff, 1995; Palloff & Pratt, 1999; Phipps & Merisotis, 1999; Twigg, 1994). They acknowledge that the online courses increase access to students; however, they fear that Internet-based courses place more emphasis on delivery of instruction rather than on student learning. Davidson (1995) suggested that educators should never consider gathering a collection of texts, audio-video, and other reference material and simply dropping them on the table and expecting our students to learn from them. In other words, simply publishing an electronic course or information on the World Wide Web with links to other pages or other digital resources does not constitute instruction (Khan, 1997; Peraya, 1995). Rather, designing and delivering instruction on the Web requires thoughtful analysis and investigation on how users interact with the Web and how they learn via an Internet-based learning environment (Khan, 1997).

In the past, distance education has been well-embraced by some disciplines including medicine, engineering, computing, and business studies, while its acceptance in other disciplines has been less extensive (Division of Government and Public Affairs, 2000). Recently, distance education has been widely adopted by all disciplines, especially science fields. For example, a recent study (Butlerm, 2001) showed that the Internet courses offered by geosciences departments in the USA and Canada have an average of 6.75 courses per department in 2000, up from an average of 2.5 in 1997. Comprehensive data are not available on the number of undergraduate biology degrees or the number of programs fully or partially offered through distance education. However, interest in

delivering and taking biology courses and entire programs via the Internet is growing (Division of Government and Public Affairs, 2000). The increase of Internet biology courses is not only due to the demand from traditional disciplines (botany, zoology, physiology, anatomy) but also from other fields. Since the1970's, modern biology has had a host of different relationships and interweavings with the social sciences, health sciences, and other natural sciences. Traditional biology has been fragmented, hybridized, and reshaped into hundreds of new ways, for example, sociobiology, biomedicine, molecular biology, computational biology, biochemistry and biophysics (Hurd, 1997). A variety of biology courses has been developed and designed for non-biology majors and employers with specific needs. In addition, the enrollment of biological sciences majors has been increasing since 1975 (Science and engineering indictors 2002, 2002). Demands for biological courses have been dramatically increasing in the past few years. To expand access for increasing audiences and enrollments, instruction delivered via the Internet is a very good alternative solution.

With the high demand for Internet courses, institutions should not allow access and expedience to surpass course quality and meeting individual student needs as the primary criteria for evaluating distance courses. Research efforts that further our understanding of online student learning and assure quality of instruction through this new technology must be ongoing.

Purpose of Study

The purpose of this study is to identify and investigate college biology teachers' approaches to teaching and students' learning styles, and to examine the impact of approaches to teaching and learning styles on students' approaches to learning via online

instruction. Approaches to teaching are the processes by which instructors teach, such as the conceptual change/student-focused (CCSF) approach or the information transmission/teacher-focused (ITTF) approach (Prosser & Trigwell, 1999; Trigwell & Prosser, 1996a). In previous studies, approaches to teaching were found to have relationships with students' approaches to learning in traditional classroom settings (Prosser & Trigwell, 1999). Learning styles are individuals' preferred ways to learn, such as hands-on learners or visualization learners (Garger & Guild, 1984). Numerous studies have found that learning styles have relationships to students' achievement (test scores, grades, and completion rates) in different learning environments (Gibson, 1998; Phipps & Merisotis, 1999; Twigg, 1994; Verduin & Clark, 1991). Approaches to learning are the learning processes that individuals choose to learn, and usually are used as the indicator of quality of learning (Biggs, 1987a). In different teaching/learning settings, students might choose to adopt deep approaches (meaningful learning processes) to understand the meaning and concept of the content, or adopt surface approaches (rote memorizing processes) without understanding the content. While achievements (grades, completion rate, test scores…etc) are one of the most important factors for evaluating the success of online teaching and learning, some factors such as assessment methods and formats could affect the results. Although approaches to teaching and learning styles have relationships to students' learning activities, few have examined the effectiveness of factors from both instructors and students on students' learning processes in online learning environments. Instead of measuring achievements (outcome), approaches to learning will be measured to understand students' learning processes. This study will examine the methodology of instruction and students' learning styles in online biology courses and their effectiveness

on students' approaches to learning in online learning environments.

Statement of the Problem

The growth of online courses has increased dramatically in recent years as a consequence of the ubiquity of the World Wide Web. While numerous research has been conducted, most focus on technology and web designs to improve student success/completion rate and satisfactions. However, learning outcomes are not good candidates to be used as the index of quality of learning because learning outcomes such as scores and grades could be influenced by external factors such as the types of examination, grading methodologies, and physical conditions. Thus, to measure quality of learning, students' learning process would be a better index than learning outcome. Students' learning processes such as approaches to learning can reflect how students learn in different teaching and learning environments (Biggs, 1999). Therefore, understanding students' learning processes and factors influencing qualities of learning will provide valuable information for instructors and institutes to provide quality online courses and programs.

Since approaches to teaching affect students' approaches to learning, an understanding of the nature of teaching becomes important if measures to enhance the quality of teaching are to have any impact. Furthermore, Prosser and Trigwell (1999) have argued that learning and teaching are fundamentally related; that good teaching needs to be defined in terms of helping student learning, that it is the learning by students that needs to be the focus of good teaching, not the teaching activities of teachers. In other words, good teaching is defined by students' perceptions, which is affected by

students' characteristics, such as previous experiences of learning and teaching, and their preferred styles to learning.

Individuals' preferred styles of learning, called learning styles, have a relationship to their achievement in different teaching/learning environments (Gibson, 1998; Phipps & Merisotis, 1999). Learning style is the process of attaining and retaining information, and is a stable and pervasive characteristic of an individual (Garger & Guild, 1984). According to Keefe (1987), learning styles are hypothetical constructs that helps to explain the learning process. However, learning styles explain individuals' preferred ways to learn but not truly how they learn. Newstead (1992) used Kolb's Learning Style Inventory (LSI) and Approaches to Study Inventory (ASI) as tools for measuring learning styles and approaches to learning, respectively, to find if there is any relationship between these two scales in traditional classroom settings. In the study, the activity dimension and abstract conceptualization on the LSI and meaningful approaches on the ASI, both relating to student's success, did in fact correlate with each other. Since an individual's learning style is a stable characteristic and affects achievement, Newstead's study (1992) implies that learning styles play a role in individuals' decisions to adopt approaches to learning based on teaching/learning settings which have similar implications to those suggested in Prosser and Trigwell's research (1999).

There has been little research, however, that studies both teaching approaches (student-focused approaches or teacher-focused approaches) and students' learning styles (hand-on style or visualized style) on students' approaches to learning (meaningful approaches or rote memorized approaches) in the online environment. There is urgency for this type of research since both sets of factors are important and have relations with

each other regarding their influences on students' learning. This study, therefore, addresses the issue of students' quality of learning by examining the impact of teachers' approaches to teaching, and students' learning styles on approaches to learning in college online biology courses.

Research Questions

In order to identify the impact of teachers' approaches to teaching and students' learning styles on approaches to learning in college online biology courses, the following research questions are proposed.

1. What is the impact of students' learning styles based on Kolb's LSI on students' approaches to learning in college online biology courses?
2. What is the impact of teachers' approaches to teaching on students' approaches to learning in college online biology courses?
3. What is the impact of teachers' approaches to teaching and students' learning styles on students' approaches to learning in college online biology courses?

Definitions

The variables of interest in this study are defined in this section.

1. *Approaches to learning* are most commonly described in terms of a two-category model, with the labels: deep and surface (Marton & Säljö, 1976). Students concentrating on understanding the course material can distinguish the former from the latter. Students adopting a surface approach focus on the material itself, thus relying upon memorization. Students adopting a deep approach have the intention to seek the underlying meaning of what they read and actively relate it to

their own experience and needs. Biggs (1987a) has described each approach as having a motive and strategy component.

2. *Conceptual change/student-focused approach* is a scale measured by the Teaching Approach Inventory (Prosser & Trigwell, 1999; Trigwell & Prosser, 1996a). Teachers adopting a conceptual change/student-focused strategy aim at changing their students' conceptions.
3. *Distance education* refers to educational instruction with the most important element being the physical separation between the teacher and the learner for most of the instruction.
4. *Distance learning* is considered as the same as distance education. However, distance learning was used when the focus is learning issues.
5. *Deep approach* is the strategy toward studying adopted by those students with the intention to seek the underlying meaning of what they read and to actively relate it to their own experience and needs (Kember, 1998).
6. *Information transmission/teacher-focused approach* is a scale measured by the Teaching Approach Inventory (Prosser & Trigwell, 1999; Trigwell & Prosser, 1996a). Teachers adopting an information transmission/teacher-focused strategy have the intention of transmitting information to students.
7. *Learning styles* are "… stable and pervasive characteristics of an individual, expressed through the interaction of one's behavior and personality as one approaches a learning task" (Garger & Guild, 1984). Evidence strongly suggests that the dominant qualities of a learner's style are unchangeable (Garger & Guild, 1984).

8. *Meaningful learning* as a process presupposes both that the learner employs a meaningful learning set and that the material he learns is potentially meaningful to him (Ausubel, 1968).
9. *Online courses* may include an on-campus residency, but the majority of the learning component consists of students accessing course assignments and discussions with professors and classmates via the Internet.
10. *Surface approach* is the strategy toward studying adopted by those students with little or no intention to seek the underlying meaning of what they read and to actively relate it to their own experience and needs. They tend to concentrate on trying to rote-learn factual details, which they presume will be relevant to examination questions (Kember, 1998).

Conceptual Framework

The conceptual framework for this study is based on the presage-process-product model (3P model) of teaching and learning (Biggs, 1987a; Prosser, 1994). The 3P model of teaching and learning illustrates the student learning process and describes three points in time at which learning-related elements take place: presage, before learning takes place; process, during learning; and product, the outcome of learning. The model was adapted from Dunkin and Biddle's (1974) presage-process-product model. Presage-process-product model starts from the context of classroom teaching and students' previous learning experience (presage) to student learning process (process), and then learning outcome (product). The three elements create an interactive system. The 3P model of teaching and learning is illustrated in Figure 1.1.

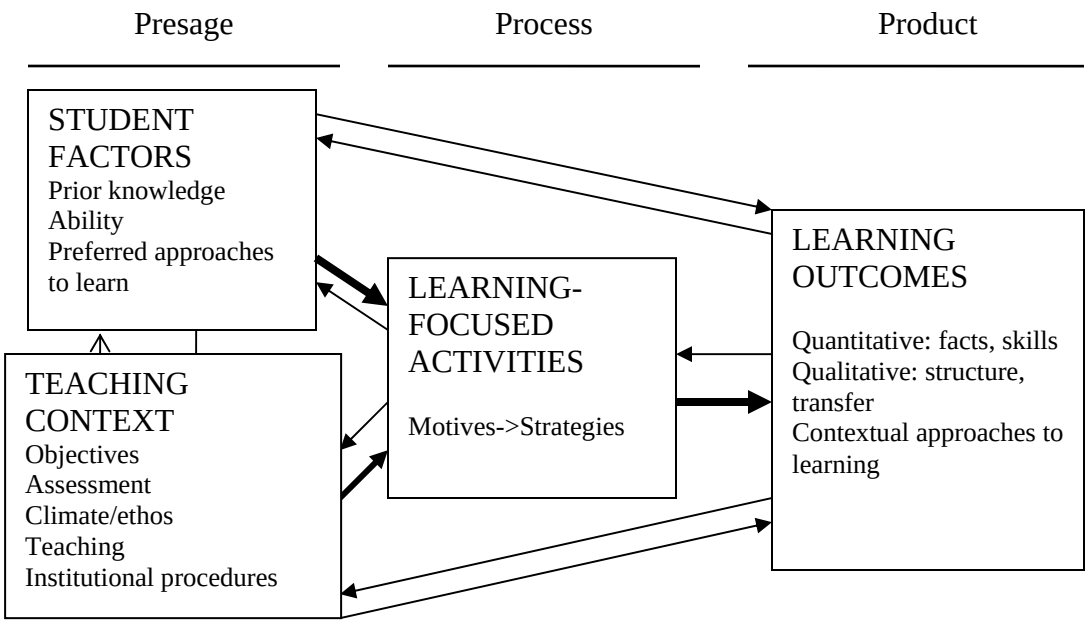

Figure 1.1: The 3P model of Teaching and Learning. Adapted from *Teaching for Quality Learning at University*, Biggs, J. (1999). Philadelphia, PA, SHRE and Open University Press.

Presage factors exist prior to actual engagement in learning, and are of two kinds: (a) Student presage factors, which are relatively stable and learning-related characteristics of the students such as: prior knowledge, abilities, values and expectations concerning achievement, and of immediate relevance to the present paper, approaches to learning as predispositions to engage in academic activities according to prevailing motives and strategies; and (b) Teaching presage factors which are contextual, including the superstructure set by the teaching and the institution: the course structure, curriculum content, methods of teaching and assessment, and classroom climate (Biggs, 1999).

The two sets of factors interact. For example, teachers' perceptions of students' abilities or conceptions of teaching could affect their teaching decisions, while students' perceptions of the teaching context directly affect their motives and predispositions, and their immediate decisions for learning process. The interaction of two presage factors leads toward the decision and action of learning processes, or "process" stage. "Process" includes two quite different meanings: the metacognitive one of deciding how, as a general strategy, to handle the task in context; and the tactical meaning which simply refers to which cognitive processes, whether higher or lower level, are used. Prosser (1994) used Student's Perceptions of Context to interpret the metacognitive decision to handle the task. In their study, there is a positive relationship between students' perceptions of quality of teaching and student's approaches to learning.

The learning outcome, or "product" stage, is determined by many factors interacting with each other. As shown in Figure 1.1, the heavy arrows mark the general direction of effects. Here is where the student and teaching presage factors jointly determine the approach a student will use for a given learning task, and that in turn determines the quality of the learning outcome. The light arrows connect the items to each other, making the model a system within the classroom (Biggs, 1993). In this way, all the components affect each other, explaining why no two classes are ever the same even with the same teacher. This system is contained within the larger institutional system acting upon it and demands that the classroom system strike a balance with it. In sum, the 3 P model portrays the classroom as an interactive system in which student characteristics and the teaching context jointly determine on-going deep or surface learning activities, which in turn determine the quality of the learning outcomes.

Assumptions

The following assumptions are identified for this study:

1. Students' learning styles in this study can be used as students' presage factors regarding Biggs' 3P model of teaching and learning.
2. Learning style preferences are measured in two dimensions. Over time, learners develop preference for either concrete experiences when learning or a preference for engaging in abstract or conceptual analyses when acquiring skills and knowledge (Kolb, 1976). Students learn best when settings can match their learning styles. Learning style is one of a student's characteristics.
3. Students' approaches to learning result from the interaction between their previous experiences of learning and teaching and the learning and teaching context itself. They approach their studies in relation to their perceptions of the context, and that approach is related to the quality of their learning outcome (Biggs, 1978; Prosser, 1994).
4. Study participants will answer survey questions to the best of their knowledge.

Limitations

The following limitations are identified in this study:

1. A convenient sample will be used in this study due to restricted time and resources. This may limit the ability to generalize results.
2. Answers to the survey questions may be biased for a variety of reasons. Social desirability and information bias as a result of peer pressure may affect subjects' answers.

3. The cross-sectional design (data are colleted at one point in time) is used in this study. Thus, it represents the participants' perception and knowledge in relation to the circumstances and experiences at the time of data collection only. It may not represent their perceptions and knowledge at another time.
4. Online survey may have low survey return rates

Summary

This chapter presents the purpose, background and significance, the statement of problem, research questions, definitions, assumptions, and limitations of the study. The purpose of this study is to identify and investigate college biology teachers' approaches to teaching and their students' learning styles, and to examine the effects of these approaches and learning styles on students' approaches to learning as the students participate in Internet-based instruction. Previous research has been completed regarding relationships between students' learning styles and their achievement in different learning environments. Approaches to teaching have also been found to be important factors that influence student's approaches to learning (Prosser, 1994; Prosser & Trigwell, 1999).

The growth of online courses has increased dramatically in recent years as a consequence of the ubiquity of World Wide Web. However, there is a notable lack of research in the cited literature providing evidence that online distance education promotes the quality of' independent learning to which it aspires. Quality of learning should be measured by students' learning processes instead of learning outcome because learning processes won't be influenced by the types of examination, grading methodologies, physical conditions…, etc. Since approaches to teaching affect students' approaches to learning and subsequent learning outcome, an understanding of the nature of teaching

becomes important if measures to enhance the quality of teaching are to have any impact regardless of the medium. Furthermore, good teaching is defined by students' perceptions, which is affected by students' characteristics, such as previous experiences of learning and teaching, and their preferred styles of learning (Prosser & Trigwell, 1999). Individuals' preferred styles of learning, called learning styles, have a relationship with students' learning process (Newstead, 1992). Furthermore, Newstead's study also implies that learning styles play a role in individuals' decisions to adopt approaches to learning based on teaching/learning settings, which has similar implications to those suggested in Process and Trigwell's study (1999).

The conceptual framework of this study is Biggs' presage-process-product (3P) model (1978). Presage factors exist prior to actual engagement in learning, and include students' presage factors and teaching presage factors. Those two presage factors interact in the process stage, and then influence learning outcomes such as test scores, grades, and completion rate. Students' learning styles and instructor's approaches to teaching are the factors of the presage. In the process stage, students will adopt approaches to learning as the results of interaction of presage factors. The learning outcome, or "product" stage, is determined by many factors interacting with each other. To eliminate those factors, approaches to learning is used to measure the quality of learning.

This study is one of the first to explore the relationship among teachers' approaches to teaching, students' learning styles and approaches to learning in biology courses taught via the Internet. This research will contribute to the existing body of knowledge on what constitutes good university teaching and effective online instruction.

CHAPTER 2: REVIEW OF THE LITERATURE

Learning has been the subject of research by psychologists and educators for the whole of the twentieth century, but remarkably little has directly resulted in improving teaching. The reason is that until recently psychologists were more concerned with developing the One Grand Theory of learning than in studying the contexts in which people learned, such as schools and universities (e.g., Biggs, 1993). This focus has been rectified in the past twenty years or so, and there is now a great deal of research into the ways that students go about their learning. Appropriately, the recent field of study is now designated as "student learning" research.

In the broadening field of student learning research, psychologists and educators have become increasingly aware of student learning processes and factors affecting them, such as teaching context and student characteristics. According to Cochran (1993), knowing how students approach learning is an important aspect of pedagogical content knowledge and helps not only to improve students' learning skills but also to improve teaching. Ramsden (1998) suggested that learning means changing students' conceptions; teaching then means discovering students' current conceptions and helping to change them. This suggests that teachers' approaches to teaching that help students work on discrepancies in more preferred ways are more likely to be appropriate and successful (Dart & Boulton-Lewis, 1998). Furthermore, Biggs (1993) pointed out that the effect of approaches to study scales on examination performance are modified by personality characteristics, and by the congruence between motives and strategies. Thus, understanding individual characteristics such as educational background and learning styles are an essential foundation for teachers to help student to succeed. To investigate the relationships among

students' study approaches, approaches to teaching, and individuals' learning, Biggs's presage-process-product (3P) model (1987a) is useful (Figure 2.1). In this study, approaches to teaching and individual learning styles are the presage factors and study approaches are in the process stage, which is affected by presage factors from individual characteristics, teaching context or both. This research will focus mainly on three themes: (1) knowing students' learning styles (Kolb, 1976) and their impacts on approaches to learning (Biggs, 1987a), (2) knowing teachers' approaches to teaching (Prosser, 1994) and their impacts on study approaches and (3) knowing the impacts of students' learning styles and teachers' approaches to teaching on study approaches.

This chapter includes a literature review of studies related to teachers' approaches of teaching, learning styles as well as studies related to the students' approaches to learning. Each of these major concepts is further divided into subcategories for discussion.

A Teaching/Learning Model

A presage-process-product model (3P model) of teaching interprets the student learning process and describes three points in time at which learning-related elements take place: presage, before learning takes place; process, during learning; and product, the outcome of learning (Biggs's, 1978; Prosser el al., 1994). A simplified version of the 3P model, shown in Figure 2.1, will be used in this chapter to illustrate a general system of student factors, teaching context, approaches to learning, and the learning outcomes.

Presage factors refer to what exists prior to engagement that affects learning. On the student side this includes such factors as students' preferred learning approaches, ability, and their previous learning experiences. On the side of teaching context are the nature of the content being taught, teaching conceptions, methods of teaching and assessment, the

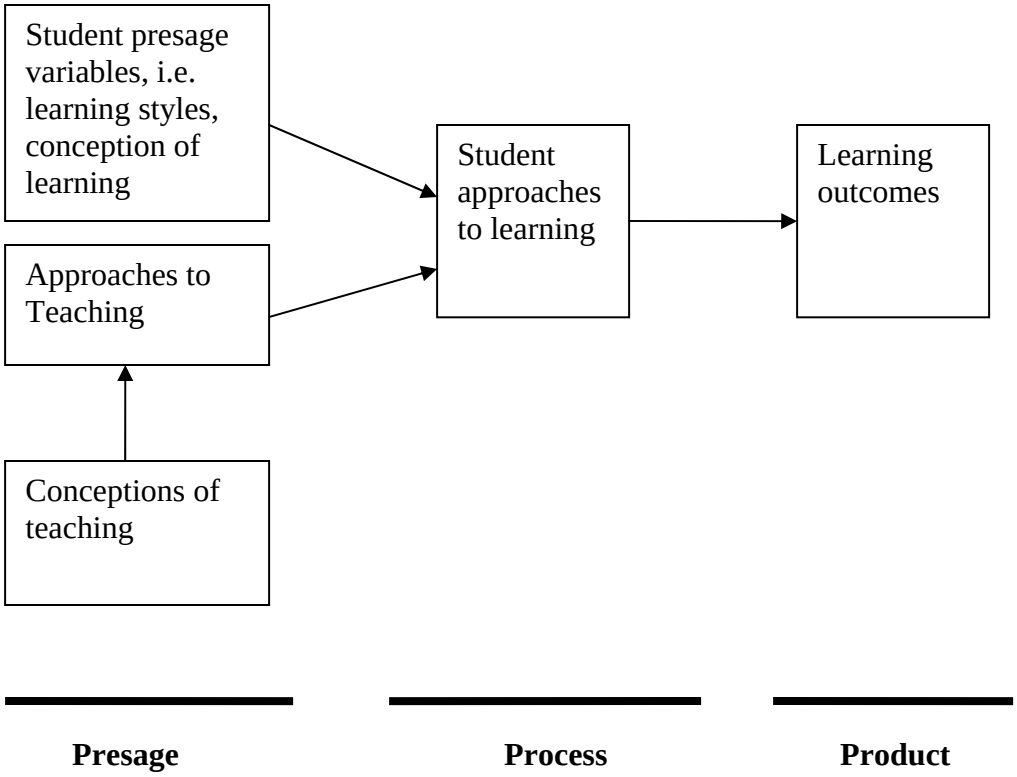

Figure 2.1. Conceptions of teaching, approaches to teaching, students' presage factor, and learning process related in a 3P model.

institutional climate and procedures, and so on. These factors interact to determine the on-going approaches to a particular task, which in turn determine the outcome.

The core of the teaching/learning system is at the process level, where the learning related activity either does or does not produce the desired outcomes. How students learn is the main key to the quality of learning. As Shuell (1986) describes it, "If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving those outcomes. It is important to remember that what the student does is more important than what the teacher does."

A generic way of describing "what the student does" is precisely in terms of their on-going approaches to learning. There are many possible interactions between students' learning approaches and instructors' teaching strategies. A student who typically picks out likely items for assessment and rote-memorizes them finds that strategy will not work under comprehensive assessment, so chooses a deep approach. Another student, who normally interacts deeply, may decide to go a surface approach in a module that is overloaded with content and assessed by poorly constructed multiple choice questions. The generic aim of good teaching is to encourage students to adopt a deep approach and to discourage the use of a surface approach (Biggs, 1999). Thus, students' approaches to learning in a class give an index of quality of the teaching in that class.

Students' approaches to learning may normally have a predisposition to either a deep or surface approach to learning in general; however, the preferred approach can be modified by the teaching context or learning environment within an individual course or for a particular learning task. The prevailing approach adopted, therefore, can depend upon an altered variable in the student, such as motivation, or variables modified in the teaching-learning context, such as the type of approaches to teaching used. Although there are many studies finding deep approaches to learning will lead to better learning outcome, a bad design of assessment might cause a different result. Thus, it is reasonable to use students' approaches to learning as the index of quality of teaching and learning.

Approaches to Teaching

Research into University Teaching

In the early 1990s, several groups of researchers were working independently to examine the beliefs about university-level instructions. Some of the groups had found

that research into students' learning had established a relationship between students' conceptions of learning, approaches to learning and learning outcomes (Marton & Säljö, 1997; Ramsden, 1991; Trigwell & Prosser, 1991; Van Rossun & Schenk, 1984). The studies referred to have reported that students with a propensity toward a deeper approach to learning were taught by teachers who perceived themselves to have control over what was taught, whose class size was not too large, and whose teaching load was not too heavy. Thus, results from these studies suggested that there was a relationship between teachers' conceptions of the teaching-learning context and student learning. Based on these research results, the subsequent studies for relationships among instructors' conceptions of teaching, approaches to teaching and students' approaches to learning and outcome have been developed.

In one of the earlier studies of university teachers' conceptions of teaching, Dall'Alba (1991) interviewed 20 teachers from the fields of economics, English, medicine and physic in Australian universities. Seven different ways were identified in how those teachers conceived of or understood their teaching in their particular teaching situations. They are:

1. Teaching as presenting information
2. Teaching as transmitting information
3. Teaching as illustrating the application of theory to practice
4. Teaching as developing concepts/principles and their relation
5. Teaching as developing the capacity to be expert
6. Teaching as exploring ways of understanding from different perspectives
7. Teaching as bringing about conceptual change.

In discussing these conceptions, Dall'Alba (1991) argues for a logical ordering:

> The categories described above are ordered from less to more complete understandings of teaching. At the lowest level, teaching is seen in terms of the teacher alone and, more particularly, in terms of what teacher does. From there, the focus shifts to incorporate the content and, at higher levels, students' understanding of the content becomes prominent. Finally the most complete conception focused on the relationship between teacher, students and content. (p. 67)

In this quote, Dall'Alba highlights the idea that there are conceptions of teaching which are more or less complete in that the later conceptions go beyond and/or include aspects of the former conceptions but not vice versa. Similar conceptions and their relationships have been identified in other studies (Martin & Balla, 1991; Prosser, 1994; Samuelowicz & Bain, 1992).

In a quantitative study, Gow and Kember (1993) found a relationship between lectures' conceptions of teaching and students' approaches to learning. From Kember and Gow's Lecturer's Conceptions of Teaching and Learning Questionnaire (Gow & Kember, 1993; Kember & Gow, 1994), departmental scores were obtained for two main orientations to teaching: knowledge transmission and learning facilitation. These were related to measures of students' approaches to learning from the Study Process Questionnaire (Biggs, 1987b). The results showed that orientations to teaching had significant correlations with changes in students' approaches to learning. Each department score was the mean of faculty's scores from Lecturer's Conceptions of Teaching and Learning Questionnaire. Departments with scores more attuned to learning

facilitation were less likely to promote a surface approach to learning. Departments with high mean scores on the knowledge transmission orientation tended to depress the use of a deep approach to learning. Hence, a relationship was established between teachers' conceptions of teaching and their students' approaches to learning.

There have been very little relational research into university teachers' conceptions of teaching, and even less into their approaches to teaching. In the past ten years, just over ten investigations have reported on university teachers' teaching experiences. Most have been on conceptions of teaching (Kember, 1998). All studies reported similar results, showing variation from limited to more complete ways of conceiving what teaching is about. The range constituted by Prosser (1994) is typical of the variation found. The more complete conceptions involve facilitating students change their conceptions of subject matter, while the limited conceptions involve transmission of the subject information or teachers' understanding. The more complete conceptions of teaching are thought to be related to an awareness of more aspects of teaching. For example, teachers working with this conception may see the purposes of teaching as increasing knowledge through the transmission of information, helping students acquire the concepts of the discipline, developing their conceptions and changing their conceptions. Those who work with the more limited conceptions may not see the purpose of teaching as being any more than an increase in student knowledge through the transmission of information.

In a study of teachers' approaches to teaching in first year university physics and chemistry subjects, Prosser and Trigwell (1999) identified five qualitatively different approaches, each with a focus on the strategies teachers adopt for their teaching and the intentions related to the strategies. There are two qualitatively different groups of

approaches within the range. The first group has a teacher- or content-focus with the intention of transmitting information or the content to students. These approaches are in contrast to those in the second group, where the focus is on the student, and the intention is to develop or change the student's conceptions of the material being learned (Trigwell et al., 1994).

Teachers who had prior experiences of teaching involving the more complete conceptions of teaching were found to be more likely to adopt approaches to teaching in the students-focus way, while the more limited conceptions were related to teacher-focused transmission approaches (Trigwell & Prosser, 1996b). Relations have also been observed between teachers' conceptions of their teaching context and their approaches to teaching. These results suggest that if teachers perceive that they have some control over what is taught and how it is taught, then they are likely to adopt more of a student-focused approach to teaching. An information transmission/teacher-focused approach is related to variables that the teaching unit does not have a strong commitment to students' learning, and the teacher has little control over what is to be taught.

Kember and Kwan (2001) established a relationship between teachers' approaches to teaching and their conceptions of good teaching, and developed a model linking teachers' beliefs to approaches to teaching and, in turn, to student learning outcomes. Lecturers were interviewed individually about their conceptions of good teaching, about their motivational strategies, and about what constituted effective teaching. Kember and Kwan suspect that teachers' approaches to teaching are likely to have a predominant or preferred approach, like students' approaches to study, which have a more stable

preferred or dominant approach. In addition, the conception of teaching is one of the important factors to determine teachers' approaches to teaching.

Teaching/Learning Theories Related to Teaching Practices

The spectrum of learning theories consists of many approaches or ways of explaining how humans learn. The extremes of this learning theories spectrum are presented by the Behaviorist and Constructivist theories (Figure 2.2). As theories trying to explain the same thing, they are bipolar based on their respective views of how knowledge is acquired and the intervention of tools of learning which are teaching methods. Thus, these two learning theories will also be seen as teaching theories which have long been applied to instructional methods.

Behaviorism

Over past six decades, Behaviorism has served well in teaching an increasing North

Behaviorism ⟷ Constructivism	
Directed Instruction	Non-directed Instruction
Objectivist	Constructivist
Teacher-centered	Learner-centered
Behavioral observations	Cognitive operations
Focus on the individual	Group work is emphasized
More focused on one approach	More holistic in approach

Figure 2.2. Summary of Behaviorism and Constructivism in teaching and approaches to learning. Adapted from Forrester, D. & Jantz, N. (2002). *Learning theories*.

American population. Behaviorist learning theory and their teaching practices are well studied and documented. Behavioral learning theory manifested itself in creating a systematic approach to teaching. The concern of Behaviorism is an observable indicator that learning is taking place. Approaches to learning using Behavioral learning theory is often referred to as directed instruction since all learning activities are directed and can be observed through instruction.

The focus of Behaviorism is on the conditioning of observable human behavior. Watson, the father of Behaviorism, defined learning as a sequence of stimulus and response actions in observable cause and effect relationships (Kentridge, 2004). The behaviorists' example of classical conditioning demonstrates the process in which an individual learns to respond to a neutral stimulus in such a manner as would normally be associated with an unconditioned stimulus. The stimuli that humans receive may be generated internally (for example, hunger), or externally (for example, a loud noise) (Kentridge, 2004). Skinner expanded on the foundation of Behaviorism, established by Watson, by focusing on operant conditioning. According to Skinner, voluntary or automatic behavior is either strengthened or weakened by the immediate presence of a reward or a punishment.

Belkin and Gray (1977) stated, "The learning principle behind operant conditioning is that new learning occurs as a result of positive reinforcement, and old patterns are abandoned as a result of negative reinforcement" (p.59). In his book entitled, *The Technology of Teaching*, Skinner (1968) wrote, "The application of operant conditioning to education is simple and direct. Teaching is the arrangement of contingencies of reinforcement under which students learn. They learn without teaching in their natural

environments, but teachers arrange special contingencies which expedite learning, hastening the appearance of behavior which would otherwise be acquired slowly or making sure of the appearance of behavior which otherwise never occur" (p.64). Skinner (1968) also believed that more complex learning could be achieved by this process of contingencies and reinforcement "... through successive stages in the shaping process, the contingencies of reinforcement being changed progressively in the direction of the required behavior" (p.10).

Applying the theoretical principles of Behaviorism to learning environments, it is easy to recognize that we have many Behaviorist effects in our learning world. A dissection of the traditional approaches to teaching used for years would reveal the powerful influence that Behaviorists have had on learning. The concept of directed instruction, whereby a teacher is providing the knowledge to the students directly is an excellent example of the Behaviorist model of learning. Ausubel (1968) suggested that direct didactic instruction was the most effective way to teach concepts to children. Ausubel believed that this process was most effectively accomplished through the direct and orderly presentation of ideas to young developing minds by a teacher who understood the logical connections between the concepts of a particular discipline. Thus, from the point of view of the student, this approach was one of reception (pumping) learning.

Contrasting with this view of learning is the emphasis of cognitive psychologists who view learning as the mental processes of the mind. Behaviorists do not deny the existence of these mental processes. In fact, they acknowledge their existence as an unobservable indication of learning.

With the increasing usage of the computer in school, C.A.I., or computer-assisted instruction has become a prominent tool for teaching, because from a Behaviorist perspective it is an effective way of learning. CAI uses the drill and practice approach to learning new concepts or skills. The computers generate the questions as the stimuli and users response them. Based on the response a reward may be provided. Rewarding the user at a different level for correct responses follows exactly the approach of operant conditioning. CAI has been considered as an effective teaching approach because it allows for self-paced instruction. Also, it liberates them from the direct instruction of all their students so as to focus on those students with particular needs.

Constructivism

Individual and social constructivists believe that all humans have the ability to construct knowledge in their own minds through a process of discovery and problem-solving. The extent to which this process can take place naturally, without structure and teaching is the defining factor amongst those who advocate this learning theory.

Jean Piaget, a French Swiss developmental psychologist, is most well known for organizing cognitive development into a series of four stages. His four stages— sensorimotor, preoperational, concrete operational and formal operational which commence at infancy and progress into adulthood— characterize the cognitive abilities necessary at each stage to construct meaning of ones environment (Berk, 1999). Mental construction is the core element of Constructivism. Papert (1993) in his book, *The Children's Machine*, mentioned, "constructivism, my personal reconstruction of constructivism has as its main feature the fact that it looks more closely than other educational -isms at the idea of mental construction. It attaches special importance to the

role of constructions in the world as a support for those in the head, thereby becoming less of a purely mentalist doctrine" (p.142). Papert also believed that the education system should be based on constructivism since children as learners have a natural curiosity to construct meaning in their world. If the way children were being taught relegated them to a role of passive recipients of the teaching, they were not motivated to construct any learning for themselves. Constructivists view learning as a question of motivating an individual to attach new meaning to past cognitive experiences. According to Papert (1993), "constructivism does not call in question the value of instruction as such. Even the statement (endorsed if not originated by Piaget) that every act of teaching deprives the child of an opportunity for discovery is not a categorical imperative against teaching, but a paradoxically expressed reminder to keep it in check. The constructivist attitude to teaching is not at all dismissive because it is minimalist — the goal is to teach in such a way as to produce the most learning for the least teaching. Of course, this cannot be achieved simply by reducing the quantity of teaching while leaving everything unchanged. The principle parallels an African proverb: If a man is hungry you can give him a fish, but it is better to give him a line and teach him to catch fish himself" (p.139).

These desired objectives of Constructivists' view of learning are coming closer to reality as more people discover the power of computer technology, especially the Internet. With the increasing growth of technology, constructivists' dreams are becoming reality as a paradigm shift to more interactive learning due to the exploitation of the digital media and Internet that is taking place in our learning institutions. For example, the design for online courses is well fitted into constructivists' theories. One of the principles for teaching excellence for online course design is "excellent instructors are

facilitators of learning, rather then dispensers of information" (Johnson & Connick, 2003, P. 187). Interactive multimedia technology and huge internet information are two excellent tools in the online design which allow students to construct their meanings for objectives. Instructors, as facilitators, can help students' learning from their feedbacks.

The spectrum of learning theories, Behaviorism and Constructivism and all in between, is well fitted in approaches to teaching in current teaching practice and research. As shown in figure 2.2, Behaviorism from a teaching practice perspective is referred to as teacher-focus instruction and Constructivism is referred to as student- focus instruction. From the review of 14 studies in 1992-1994, Dart and Boulton-Lewis (1998) indicated that both extreme forms of teaching concepts and approaches still widely exist in current teachers. Although individual studies have defined approaches to teaching from different views, most research categorizes approaches to teaching between these two opposite poles. One study analyzed the interview data of 24 university teachers and categorized five approaches between information transmission/teacher-focused (ITTF) approach and conceptual change/student-focused (CCSF) approach (Trigwell et al., 1994). Another study, analyzing seventeen teachers' interview data, categorized approaches to teaching into content-centered approach and learning-centered approach (Kember & Kwan, 2002). Although the categories of approaches to teaching are developed through different perspectives, they are still best interpreted by Behaviorism and Constructivism teaching and learning theories.

Relations between Conceptions of Teaching and Approaches to Teaching

While there have been several empirical studies of university teachers' conceptions of teaching, there have been few, if any, empirical studies of university teachers' approaches

to teaching, and the relationship between intention and strategy in teaching (Trigwell, Prosser, & Waterhouse, 1999). Recently, Kember and Kwan (2002) reported their investigation into the relationship between lecturers' approaches to teaching and their conceptions of "good teaching." Seventeen lecturers in three departments were interviewed individually about their beliefs on good teaching and what constitutes effective motivational strategies and teaching techniques. The researchers discovered the lecturers' conceptions of teaching could be categorized into two broad approaches labeled content-centered and learning-centered. These initial categories were then compared to each other to distinguish if they were different in significant ways. The defining characteristics of their associated dimensions were portrayed as opposite poles of a series of continua as illustrated in Figure 2.3. The related conceptions of teaching were examined by allocating the lecturers to the different positions along the continuum for both their conceptions of teaching and approaches to teaching. Thus, each lecturer was placed at an approximate point on each of the continua for the six dimensions of approaches to teaching. The majority of their sample showed a predominance of positions toward either end of the two poles. These could then be designated as adopting either content- or learning-centered approaches to teaching. The content-centered approach was characterized by a focus upon the material or content that was to be taught. The learning-centered approach concentrated upon the students and sought to ensure that appropriate learning took place. Their findings indicated a high level of correspondence between a lecturer's conception of teaching and his/her approach to teaching. The content-centered lecturers were more likely to rely on extrinsic motivators, supply a lot of notes and references, focus on the whole class, employ frequent tests and quizzes, teach to their

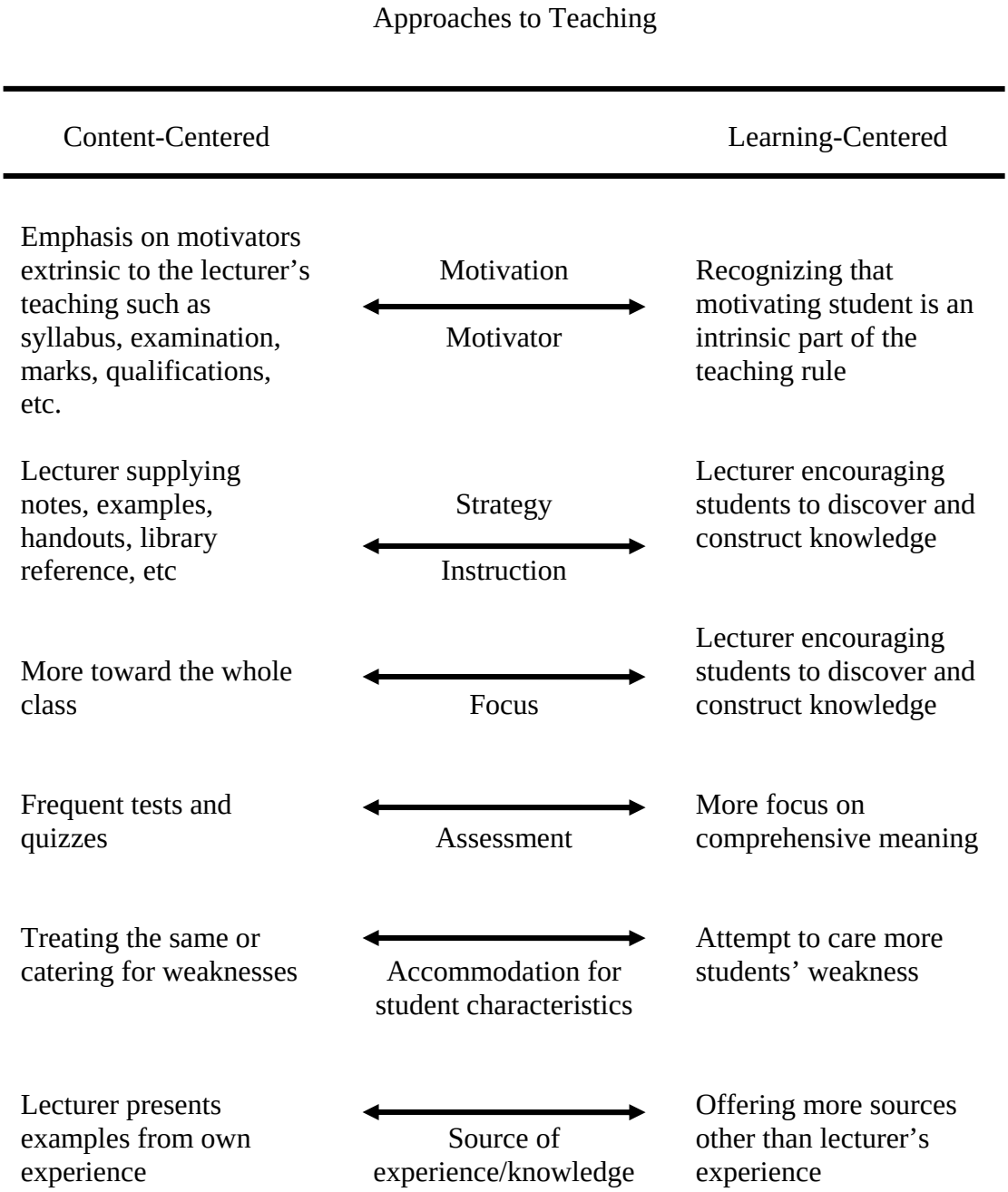

Figure 2.3. The linking between lecturers' approaches to teaching and their conceptions of good teaching. Adapted from Lecturers' approaches to teaching and their relationships to conceptions of good teaching, Kember, D & Kwan, K.P. (2002). *Teacher thinking, Belief and Knowledge in Higher Education*. Dordrecht, the Netherlands: Kluwer Academic Publishers.

students' strengths or cater to their weaknesses, and give examples and illustrations from their own experiences (Kember, 1997). The learning-centered lecturers were more inclined to recognize the need to motivate students as an intrinsic part of their role as a teacher, encourage students to discover knowledge on their own, deal with the needs of individual students, employ a more flexible system of assessment, make conscious attempts to remediate the weaknesses of their students, and respect and integrate the students' experiences into their teaching (Kember, 1997). Kember and Kwan (2002) suggested that the characterization of approaches to teaching has parallels to accepted descriptions of students' approaches to learning. There also seemed to be a greater degree of stability to approaches to teaching than to students' approaches to learning, which have been observed to switch from one learning task to another. Hence, this study provided a more complete characterization of teachers' conceptions with their approaches to teaching at the tertiary level. In addition, this study suggested the reasonable assumption that a teacher's conceptions of teaching will be influenced by "curriculum design and departmental and institutional pressures and by the nature of the students" (Kember & Kwan, 2002). However, the extent to which these other factors modify the impact of beliefs upon the teaching approach is likely to vary with the nature of the institution, the course, and the students.

Judged by the results of student learning research, the identification of the intentions underlying various teaching strategies should be a vital component (Trigwell, Prosser & Waterhouse, 1999). In a series of studies looking at 24 university teachers' conceptions of teaching, approaches to teaching and relationships between conceptions of teaching and approaches to teaching, they identified six conceptions of teaching and five

approaches to teaching (Trigwell, et. al., 1994). The six teaching conceptions were identified as: Teaching Conception A: Teaching as transmitting concepts of the syllabus; Teaching Conception B: Teaching as transmitting the teachers' knowledge; Teaching Conception C: Teaching as helping students acquire conceptions of the syllabus; Teaching Conception D: Teaching as helping students acquire teachers' knowledge; Teaching Conception E: Teaching as helping students develop conceptions; and Teaching Conception F: Teaching as helping students change conceptions.

The hierarchical relationship between these conceptions of teaching is summarized in the following quote by Prosser and Trigwell (1999):

> The purposes of teaching are to increase knowledge through the transmission of information to help students acquire the concepts of the discipline, develop their conceptions and change their conceptions. (p. 23)

The quote exemplifies the hierarchical relationship between conceptions of teaching described by Dall'Alba (1991) in terms of being less to more complete conceptions. For example, teachers who conceive teaching as helping students change conceptions (Teaching Conception F) have more complete conceptions than those who conceive teaching as transmitting the teachers' knowledge (Teaching Conception B).

In the same series of studies, the five qualitatively different approaches to teaching were identified as: Approach A: a teacher-focused strategy with the intention of transmitting information to students; Approach B: a teacher-focused strategy with the intention that students acquire the concepts of the discipline; Approach C: a teacher/student interaction strategy with the intention that students acquire the concepts of the discipline; Approach D: a student-focused strategy aimed at students developing

their conceptions; and Approach E: a student-focused strategy aimed at students changing their conceptions (Trigwell et al., 1994).

They concluded that these approaches to teaching represent a hierarchy, as with conceptions of teaching. Prosser and Trigwell (1999) indicated “where the more complete conceptions include the more limiting conceptions, but not vice versa” (p. 59). Teachers adopting Approach A, the "information transmission/teacher-focused approach," focus on what they do in the teaching- learning process since they assume students have little or no prior knowledge of the subject matter and thus do not need to be active in the process. They view teaching as the transmission of facts and skills establishing little if any relationship between them, as their purpose is to provide students with a good set of notes. To the teacher adopting Approach E, the "conceptual change/student-focused approach," it matters more what the student is doing and learning than the subject matter covered. This teacher encourages self-directed learning by making time for students to interact and to discuss problems they encounter, uses assessments to reveal conceptual change, uses a lot of time to question students’ ideas, and develops a conversation with students in lectures. From this qualitative study, Trigwell and Prosser (1996b) developed the Teaching Approach Inventory (Trigwell & Prosser, 1996b; Prosser & Trigwell, 1999) containing scales that correspond to Approach A, the “ information transmission/teacher-focused approach” and Approach E, the “conceptual change/student-focused approach”, or from a theoretical point of view, the Behaviorism approaches and Constructivism approaches, respectively.

Trigwell and Prosser (1996a) studied the relationship between the conceptions of teaching and approaches to teaching. As shown in Tables 2.1, university teachers who

Table 2.1: Relations between conceptions of teaching and approaches to teaching

Conception of teaching	Approaches to teaching					Total
	A	A/B&B	C	D	E	
A	6					6
A/B&A/C	2	1				3
B/C	5	1				6
B/D&C/D	1	1	1			3
D		2	2			4
E				1		1
F					1	1
Total	14	5	3	1	1	24

Spearman rho= .45, p< .01

Note. Adapted from Relations between teachers' and students' approaches to learning by K. Trigwell, M. Prosser & F. Waterhouse (1999). In *Higher Education*, 37, p64.

adopted a student-focused approach to their teaching of a topic conceived of their teaching in more complete ways. University teachers who approached their teaching from a teacher-focused perspective conceived of their teaching in less complete ways.

Relationship between Approaches to Teaching and Approaches to Learning

The qualitative studies by Patrick (1992), and Kember and Gow (1994) have identified relationship between teachers' approaches to teaching and students' approaches

to learning. Patrick (1992) distinguished three groups of secondary school history teachers' approaches to teaching. The first group focused on their presentation of the content and was very similar to Approach A, a teacher-focused strategy with the intention of transmitting information to students (Trigwell, et al., 1994). The second group of teachers identified their role as helping students to understand the history they were studying and, therefore, felt the need to be involved in the teaching-learning process. The third group of history teachers focused on the way the material was approached by the students with concern for the students' growth, similar to Approach E, a student-focused strategy aimed at changing students' conceptions (Trigwell, et al,, 1994). When asked to read an historical passage, the students' recounted the content in much the same way as their teachers had interpreted previous historical events. In a study of higher education teachers, Martin and Ramsden (1998) reported on relations of how six teachers conceived of teaching creative writing and on the four qualitatively different ways in which the students' responded to studying in their creative writing classes. In three of the case studies, they found evidence of a relationship between the teachers' approaches to teaching and the self-reported responses of the students in their respective classes. These studies provided evidence of a relationship existing between the teachers' approach and the students' responding approaches.

In a more recent study, Trigwell et al. (1999) specifically explored quantitatively the extent to which an information transmission/teacher-focused (ITTF) approach to teaching was associated with a surface approach to learning, and a conceptual change/student-focused (CCSF) approach to teaching was associated with a deep approach to learning. Data was collected from 48 first year university chemistry and physics classes,

comprising a total of 3,956 students and 46 teachers. The teachers completed the Teaching Approach Inventory (Prosser & Trigwell, 1999; Trigwell & Prosser, 1996b) and the students completed a version of the Study Process Questionnaire (SPQ) (Biggs, 1987b) modified to suit the specific subject-context of the study. Both teachers and students were asked to complete the questionnaires in relation to the particular lecture topic being taught to the students (Trigwell et al., 1999). The authors reported that an information transmission/teacher-focused (ITTF) approach to teaching was strongly associated with surface approaches to learning and that a conceptual change/student-focused (CCSF) approach to teaching was associated, but less strongly, with a deep approach to learning (Trigwell et al., 1999). Their research suggested that in those classes in which teachers reported adopting more of an information transmission/teacher-focused approach to teaching, their students reported adopting a more surface approach to learning. Conversely, in those classes in which teachers reported adopting less of an information transmission/teacher-focused (ITTF) approach to teaching, their students reported adopting more of a deep approach to learning. The results were derived from analyses conducted in two phases, using the class as the unit of analysis. The first phase consisted of a factor analysis of principal components of the teacher's approach to teaching and students' approach to learning variables. The results are shown in Table 2.2. The second phase, consisted of a cluster analysis, followed by between group contrasts among resultant clusters to look at subgroups of teachers and students. The summary of this analysis is shown in Table 2.3. The results of the factor and cluster analyses both showed relations between teachers' approaches to teaching and students' approaches to learning. The reported findings from this study have completed the link between

Table 2.2: Principal components factors analysis of the teacher's approaches to teaching and students' approach to learning variables

Approach variables	Factors 1	2
Students' Deep Approach to Learning (Class Mean)	-76	
Students' Surface Approach to Learning (Class Mean)	69	-38
Teacher's CCSF Approach to Teaching		97
Teacher's ITTF Approach to Teaching	66	

N=48, Decimal points removed, loadings between -0.30 and 0.30 deleted
CCSF Conceptual Change/Student-Focused
ITTF Information transmission/Teacher-Focused
The principal components explained 64% of the variance

Note. Adapted from "Relations between teachers' and students' approaches to learning" by K. Trigwell, M. Prosser & F. Waterhouse (1999). In *Higher Education*, 37, p. 64.

teacher's approach to teaching and students' approaches to learning as shown in the model of established links between teachers' conceptions of teaching and learning and students' learning outcome.

Table 2.3: Summary for the Approaches to Learning and Approaches to teaching variables by cluster membership
(N=48)

Approach variables	Cluster 1 (n=19)		Cluster 2 (n=29)	
	Mean	SD	Mean	SD
Students' Deep Approach to Learning (Class Mean)	-0.57	0.99	0.38	0.38
Students' Surface Approach to Learning (Class Mean)	0.59	0.85	-0.39	0.92
Teacher's CCSF Approach to Teaching	-0.24	1.09	0.16	0.92
Teacher's CCSF Approach to Teaching	0.72	0.64	-0.47	0.91

Hierarchical cluster analysis using Ward's Method
Contrasts between standardized means for all variables, except the CCSF Approach to teaching, statistically different at the $p<0.01$

Note. Adapted from "Relations between teachers' and students' approaches to learning" by K. Trigwell, M. Prosser & F. Waterhouse (1999). In *Higher Education*, 37, p. 64.

Learning Styles

Research into Learning Styles

The process of acquiring and retaining information, or learning style, has been studied by social scientists for decades. Significant research in the field began in the 1940's and

1950's (Stevens, 1985). Foundational learning style research began in 1945 with studies performed at Brooklyn College (Karrer, 1988). Research was primarily based on children and animals prior to 1945. Recently it has become more widely accepted that the individual characteristics of learners, or learning styles, can affect the receiving and processing of information (Fincher, 1995).

Garger and Guild (1984) described learning style as "… stable and pervasive characteristics of an individual, expressed through the interaction of one's behavior and personality as one approaches a learning task." According to Keefe (1987),"Styles are hypothetical constructs that helps to explain the learning (and teaching) process. They are qualities in the behavior of individual learners that persist regardless of the teaching methods or content experienced" (p. 5). The evidence strongly suggests that the dominant qualities of a learner's style are unchangeable.

Understanding students' learning styles is important for the quality of instructional design. The Center for Lifelong Learning at American Council on Education (1996) in its publication entitled *Guiding Principles for Distance Learning in a Learning Society*, notes, "The diversity of learners, learning needs, learning contexts and modes of learning must be recognized if the learning activities are to achieve their goals" (p. 11). Evans (1994), Gibson (1998) and Verduin & Clark (1991) claim that instruction at a distance must be systematically designed and based on knowledge of how human beings learn. Schroeder (1993) states that being aware of students' differences in learning styles and how their styles impact and interact with the academic and learning environment can assist in "designing learning opportunities and academic programs that respond effectively to the diversity of learning characteristics exhibited in today's students" (p.

25). He describes today's students as having a preference for the concrete/sensing mode of perceiving. They need direct experience, structure, sequential learning, and often have a need to know why before doing something. All agree there should be less emphasis on evaluating how well a faculty member has taught and more on what students have learned and that instruction must include connections based on students' needs and experiences.

There is not an overabundance of research on learning styles (Gibson, 1998; Phipps & Merisotis, 1999; Twigg, 1994; Verduin & Clark, 1991). Most of the studies focus on the discovery of relationships between learning styles and specific student achievement outcomes such as grade, drop rate, completion rate, attitudes about learning, and predictors of high risk. One of the most popular learning style inventories, which are often used in distance learning research, is the Kolb Learning Style Inventory (LSI) (Kolb 1976). Kolb's LSI measures student learning style preference in two dimensions. Over time, learners develop a preference for either concrete experiences when learning or a preference for engaging in abstract or conceptual analyses when acquiring skills and knowledge (Kolb 1976). They also may emphasize interest in turning theory into practice by active experimentation, or they may prefer to think about their experiences by reflective observation (Dille & Mezack 1991). People with higher scores on concrete experience tend to exhibit a greater sensitivity to feelings and thus would be expected to require more interactions with peers and the teacher. Because distance learning courses often lead to social isolation and require greater reliance on independent learning skills, students with less need for concrete experience in learning may be expected to be better suited to the distance format. Dille and Mezack (1991) used Kolb's LSI to identify predictors of high risk among community college telecourse students. Successful students

had lower scores on their preferences for concrete experiences than did the unsuccessful students. Successful telecourse students also preferred to look for abstract concepts to help explain the concrete experiences associated with their learning. Dille and Mezack concluded that students who needed concrete experience and were not able to think abstractly were more high-risk in a telecourse. Recent research shows the similar results in Internet based courses (DiBartola, Miller, & Turley, 2001). However, Day, Raven & Newman (1998) did not find significant correlation between learning styles and achievement in Internet-based communication courses.

Researchers argue that student learning styles have implications for Internet course designs and teaching methods (Gibson, 1998; Phipps & Merisotis, 1999; Prosser & Twigg, 1999; Verduin & Clark, 1991). Phipps & Merisotis (1999) argued it is important to conduct further research on how individuals learn because Internet courses have the potential to individualize learning to a greater degree than previous known. Gibson (1998) suggested that as faculty members come to better understand the learners, the learners come to better understand themselves. Instruments that allow learners to assess their learning styles enable them to make plans in term of the learning strategies that will enable them to succeed. Hence, teachers must do more than provide access to information. Teachers need to truly understand the learner and design environments that facilitate learning—environments that enhance access to and success in higher education.

Keefe's Learning Style Model

Learning style theories have proposed that no one single instructional method provides optimal learning (Fincher, 1995). All learning style inventories have attempted to measure learning style preferences; however, wide differences have existed between

their various outcomes. Models are too broad, and many of the instruments are said to assess learning unevenly (Nam, 1995). Fischer and Fischer (1979) stated that learning style inventories have been called a "double-edged sword" in that they can either clarify and analyze, or can further confuse, thus making the complexities of learning style appear more simplistic than in actuality (p. 245). Not a single learning theory has it all (Keefe, 1988) and much research of the learning process still remains to be conducted (Marshall, 1995). Learning style theorists have stated that one reason for the variety of theories is that each has contributed only partial insight into a totally accurate explanation of how individuals gain and retain knowledge (Dunn & Dunn, 1979).

To clarify this situation, Keefe proposed a learning style model with three dimensions according to the concepts of various learning styles (1987). Keefe (1987) defined learning styles as "the characteristic cognitive, affective and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p.5). Based on this learning style definition, Keefe designed a learning style model with three aspects: 1) cognitive, 2) affective and 3) physiological. Keefe's aim was to categorize the conceptualizations of learning styles without classifying the measuring instruments into groups.

Cognitive styles are information processing habits representing the learner's typical mode of perceiving, thinking, problem solving and remembering (Keefe, 1987). Keefe indicated that the vast majority of research on personality-related learning variables has been in the area of cognition. Each learner has preferred patterns of perception, organization and retention that are distinctive and consistent. These characteristic differences are called cognitive styles. Wooldridge (1995) defined five dimensions of

cognitive learning styles for improving the learning process as 1) field independent versus dependent, 2) perceptual modality preferences 3) productivity environmental preference 4) conceptual tempo and 5) leveling versus sharpening.

Affective learning styles are those dimensions of the individual's personality that have to do with attention, emotion, and valuing. Keefe (1987) stated that "affective learning styles are the offshoots of these same motivational process viewed as the learner's typical mode of arousing, directing and sustaining behavior (P. 10)." As with cognitive style, affective style is a hypothetical construct. People can not directly observe affective style; it can only be inferred from a person's interaction with the environment (Keefe, 1987). Wooldridge (1995) included five dimensions in the affective learning style: 1) conceptual level, 2) Locus of control 3) achievement motivation, 4) social motivation and 5) masculine-feminine behavior.

Physiological learning styles are biologically-based modes of response that are founded on sex-related differences, personal nutrition and health and accustomed reaction to the physical environment. Physiological factors are among the most evident influences in the process of school learning. The student who is hungry, ill or malnourished behaves differently from one who is healthy. Males and females respond differently in certain learning situations (Keefe, 1987). Five dimensions of physiological learning styles that were identified by Keefe are 1) sex-related behavior, 2) health-related behavior, 3) time-day rhythms 4) need for mobility and 5) environmental elements.

According to the model of Keefe and Wooldridge, a proposed learning style might be single or multidimensional. DeBello (1989) described multidimensional models as

offering a comprehensive and responsive advance to the study of the complexity of differences that explain students' learning.

Kolb's Learning Style Theory

A definition of learning style by Kolb (1976) is useful for this study. Kolb's definition describes learners as acquiring information in characteristic ways. Some learners are active and thrive with hands-on activities; other learners are reflective. Kolb based his experiential learning model on the work of Dewey (1938), Lewin (1951) and Piaget (1970). Dewey (1938) recognized experience as an important component in the learning process. Lewin (1951) valued active participation for learning. Piaget (1970) perceived intelligence as a result of the interaction between the individual and the environment. With these concepts, Kolb believed that individuals, because of hereditary equipment, past experiences, and demands of their present environment, develop individual learning styles. Consequently, he developed a model that illustrates learning in a cycle of four stages (Figure 2.4).

Kolb's four-stage cycle begins with learner involvement in a concrete experience. The concrete experience is the basis for reflective observation. Reflection leads to logical conclusion and concept building that result in decisions and a plan of action, and finally, cycle back to new concrete experiences. Kolb has charted these processes on two axes, vertical and horizontal. The vertical axis represents the perceiving of information either from experience or from abstractions. The horizontal axis refers to the processing of information by either internal reflection on the experience or external action on the conclusions or theories (Atkinson & Murrell, 1988). Given this premise of experiential learning, a deep level of leaning is achieved when the learner is able to move through

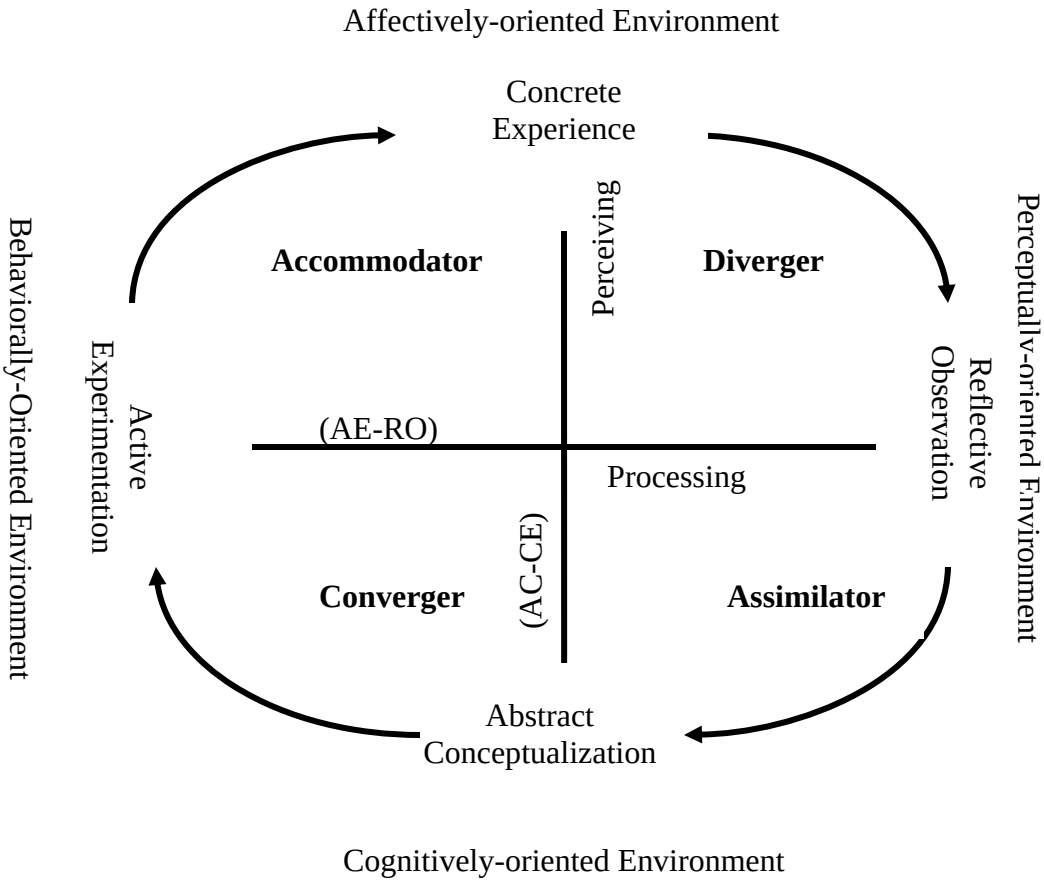

Figure 2.4: Kolb's learning style model. Adapted from *Learning Style Inventory: Self-scoring Inventory and Interpretation* Booklet, Kolb, D.A. (1984). Boston, MA: McBer and Company, p. 6

each stage. The cycle allows new learning to be added to prior knowledge. Based on this theory of learning, Kolb developed an instrument to examine the learning process of individual learners.

Kolb's Learning Style Inventory is an assessment of an individual's ability to learn experientially. According to the score of the Learning Style Inventory, learners are grouped into one of four categories: a) Abstract conceptualization (AC), b) Concrete experience (CE), c) Active experimentation (AE), d) Reflective observation (RO) (Kolb,

1984). The relative amount of abstractness or concreteness in learning style (AC-CE) and the relative degree of activity or reflection (AE-RO) determine the two composite scores. The AC-CE and AE-RO scores are then plotted vertically and horizontally on a vertical and horizontal axis, respectively, while a dominant learning style is determined. As illustrated in Figure 2.4, the quadrants with appropriate interpretation are as follows:

1. Converger (AC and AE) – strength lies in finding practical uses for ideas and theories;
2. Diverger (CE and RO) - strength in viewing concrete situations from many different points;
3. Assimilator (AC and RO)- strength lies in ability to replace large amounts of information into theoretical models or logical order;
4. Accommodator (CE and AE): strength lies in hands-on experience or in the carrying out of plans (Kolb, 1976)

Kolb proposed that a well-integrated learner would use all four modes. Most learners develop only one of these modes as being most effective due to hereditary and social experiences. Kolb's LSI (1976) reflected that individual learners of virtually any age will use varying combinations of knowledge-building approaches depending on the situation and the personality of the individual. Individual learners must have the abilities that are opposite of their strengths in order to be effective. For example, a learner with an accommodator style must also be proficient in the assimilator style. This would allow the learner to adapt to situations that require different learning styles.

Kolb's LSI has been employed as an instrument in many studies determining learning style. It is commonly used in many fields including science pedagogy, distance learning

and Internet-based learning. According to Keefe's model, Kolb's learning styles inventory would be classified as a multidimensional model that explores the physiological and affective dimension (Keefe, 1987). The physiological dimensions of learning styles include both physical and biological aspects of the environment. Physical aspects include visual, auditory kinesthetic, taste, smell and spatial characteristics. Biological aspects refer to inner rhythms such as a desire for food during study, optimal learning, health and nutrition (Corno & Mandinach, 1983; Dunn & Dunn, 1979). The affective dimensions of learning styles may also include emotional and personal characteristics such as motivation, value, interest, attention and social preference (Cornett, 1983; Keefe, 1988). That is, Kolb's learning style inventory measures personal characteristics against specific preference of internal and external learning environment. Since students' approaches to learning are affected by students' factors (internal factors) and teaching context factors (external factors), Kolb's LSI is a very useful tool for this study.

Tamaoka (1985) generalized that Kolb's LSI may connect a student's learning style with the student's subject major. The same study also reported that learning styles assessed by Kolb's LSI may be relatively stable over a fairly long time, thus supporting previous learning style theory. Sewall stated "the Kolb's LSI may be used to adequately determine a student's learning style to focus on strengths and build upon non-dominant areas" (1986). Anderson (1993) researched the effect of cognitive learning style, using Kolb's LSI on achievement and completion rates when comparing use of distance learning and traditional classroom. Using a sample of 66 undergraduate students in Iowa,

no statistically significant differences were found in the achievement scores or completion of courses via distance education and traditional classroom (Anderson, 1993).

Buergermeister (1989) compared achievements of users and non-users of computer spreadsheets using Kolb's LSI. The sample consisted of 82 undergraduates enrolled at the University of Minnesota. The study found that concept-achievement among users and non-users had no significant relationship, while work experience and concept-achievement were found to be significant. Some classifications of learning style and concept achievement were significant. Kolb's Accommodator and combination "AC-CE" had positive correlation with achievement scores, suggesting a relationship between learning style and achievement (Buergermeister, 1989).

Al-Badr (1993) sought to determine if selected variables (gender, age, computer aptitude, prior computer experience, computer ownership, and learning style) contribute to achievement in the self-instruction sections of computer application software courses at the Southern University of Illinois at Carbondale. Significant differences in achievement were found between Kolb's learning styles. Convergers produced significantly higher achievement scores than assimilators.

Connection of Learning Styles and Approaches to Learning

Newstead (1992) used Kolb's LSI and Approaches to Study Inventory (ASI) (Entwistle & Ramsden, 1983) as tools for analyzing learning styles and approaches to learning, respectively, to find if there is any relationship between these two scales in traditional classroom settings. In the study, the activity dimension (AE-RO) on the LSI and meaning orientation on the ASI, both relating to student's success, did in fact correlate with each other. Abstract conceptualization did have relationships with meaning

orientation too. At the first sight, questions about the impact of learning styles on approaches to learning are inappropriate since the two scales are measuring different things: the ASI is looking at learning orientations which are to some extent variables and context-dependent, while the LSI is looking at rather more stable and permanent aspects of learning. Nevertheless, both involve measurements of how active the person is as a learner and are used to predict academic performance in certain learning environment. It is not unreasonable to expect that there will be some connection between these measures under certain learning environments.

Kolb's learning style inventory measures a stable personal characteristic with a specific preference of internal and external learning environment. Students with a certain learning style usually have better motivation, satisfaction and performance in their preferred learning settings (McCarthy & St. Germaine, 1998). Students' approaches to learning also are determined by learning environment. Furthermore, learning styles are relatively stable learning behaviors regardless of the teaching methods or content experienced (Keefe, 1987), and have a role in students' motivation. Therefore, since motivation is one of the two components in approaches to learning (Biggs, 1987b), learning styles may be considered as one of students' characteristics, which could affect students' approaches to learning in certain learning context.

Approaches to learning

Research into Approaches to Learning

The term "approaches to learning" originated from qualitative categories of direct descriptions of study processes used by students derived from interviews and observation of students performing normal learning tasks such as reading academic articles. Marton

and Säljö (1976) identified two discrete approaches to learning: a surface approach, in which students concentrated on memorizing and reproducing key words or phases about the content of an article that seemed appropriate; and a deep approach, in which students focused on the underlying meaning and intended principle of an article. The students adopting a deep approach intended to understand the author's meaning in a piece of writing or the underlying point of an academic task. The intention of students adopting a surface approach was to regurgitate a detailed account of the content of a piece of writing without articulating the author's intended purpose or the underlying meaning of an article.

Biggs (1987a) has described approaches as having motive and strategy components with each motive-strategy combination defining a distinct approach to learning. The distinction between motive and strategy corresponds to that between intention and approach. The student's intentions largely determine the approach used, surface or deep, and the approach, in turn, determines the quality of learning outcome (Biggs, 1987a). A deep approach usually results in better academic performance. In fact, studies have consistently shown that deeper approaches to learning are related to higher quality learning outcomes (Marton, Hounsell, & Entwistle, 1997; Ramsden, 1992; Prosser & Millar, 1989; Trigwell, 1991; Van Rossium, 1984). This relationship is not as strong as it might be, however, since some assessments often demand the reproduction of transmitted information, thereby encourage a surface approach.

It is highly appropriate to propose a method for monitoring meaningful learning processes since there has been much concern recently that graduates of higher education lack qualities like critical thinking, an aptitude for self-managed learning, reflective

thinking and the ability to solve perceptible problems. Doubts as to the quality of graduates, and therefore to the quality of teaching in universities and colleges, have been expressed by several major reviews (Boyer, 1987; Daly, 1994; The National Institute on Education, 1984). The common theme within these reports and similar reviews has been the criticism that most graduates lack the qualities consistent with the clear goals and purposes of higher education. Thus, the evaluation and continuous improvement of the quality of teaching and learning in higher education is an issue of sustained concern.

There is voluminous literature on educational innovations. Different teaching methods, models of teaching, the latest educational media, new curricula, alternative assessment methods, and many other forms of innovation have been proposed as leading improvements for learning outcomes (Kember, Charlesworth, Davies, Mckay & Stott, 1997). For such claims to be believed there is a need for some form of evaluation. Two main inventories developed for use in the higher education context are the Study Process Questionnaire (SPQ) devised by Biggs (1987b, 2001) and the Approaches to Studying Inventory (ASI) authored by Ramsden and Entwistle (Ramsden & Entwistle, 1981; Entwistle & Ramsden, 1983). The SPQ and the ASI measure more meaningful forms of learning, as that is one dimension measured by these instruments. In studies, where applications of SPQ and ASI have been used to determine whether more meaningful learning has occurred, these instruments have proved to be valid and reliable indicators measuring variables within the teaching-learning context. Thus, the SPQ and ASI can be used to report a measured change in students' approaches to learning and this change can be related to innovations introduced in the teaching-learning environment.

Using this technique, various contextual variables have been found to influence the quality of student learning outcomes (Kember et al., 1997). For examples, an increase in extrinsic motivation (Gow & Kember, 1990), a lack of intrinsic interest (Fransson, 1997), the use of reproductive assessment questions (Entwistle & Ramsden, 1983; Thomas & Bain, 1984), the use of "formal " teaching methods (Ramsden & Entwistle, 1981), a focus on transmitting information (Gow & Kember, 1993; Kember & Gow, 1994), excessively heavy workload (Dahlgren, 1978), and the lack of freedom in the learning environment (Entwistle & Ramsden, 1983) have resulted in making the adoption of a surface approach to learning more likely. In addition, individual variables also have impact on students' approaches to learning. Watkins and Hattie (1981) used the 42-items version of SPQ with campus-based students at an Australian university and found that students' gender, degree major, year of study and age are factors influencing their approaches to learning.

Biggs (1989) proposed that the SPQ could be used both to inform teachers about how students respond to their teaching and to inform counselors when helping individual students. Some researchers have employed the SPQ as a diagnostic instrument in order to identify approaches to learning in individual students taking courses by distance learning in Australia (Parer, 1988; Parer & Benson, 1989). In addition, SPQ was also employed by Ekins (1992) in an investigation of distance learning students. This investigation found that students' scores on deep approaches increased and their scores on surface approaches decreased with the number of years they had been studying. Also, the students' scores on deep approaches increased and surface decreased with the grade they obtained.

Other studies measuring variables in the teaching-learning environment have shown that it is relatively common for students to adopt a deep approach in one course and a

surface approach in another (Laurillard, 1984; Ramsden, 1984). While it is true that students normally have a predisposition to either a deep or surface approach to learning in general, the preferred approach can be modified by the teaching context or learning environment within an individual course or for a particular learning task. The prevailing approach adopted, therefore can depend upon an altered variable in the student, such as motivation, or variables modified in the teaching-learning context, such as the type of approaches to teaching used.

In sum, students' approaches to learning can be influenced by students' characteristics and by the teaching context. Although many studies were conducted to investigate students' approaches to learning, most studies focused on either students' factors or teaching context factors. To investigate the students' approaches to learning, it is reasonable to include both factors.

Theoretical Framework of Approaches to Learning

Since the early 1960s, learning researchers examined the teaching-learning process as experienced by students within the classroom. Beginning in the 1970s a large body of theory developed from this "student learning research." Early learning research focused on situational factors and stable individual differences. Biggs and Kirby (1983) provided an overview of three earlier models of learning research: behaviorist, individual differences, and aptitude-treatment interaction. The behaviorist model ignored individual difference and focused on improving performance by manipulating the learning environment through reinforcement. The individual difference model held that variations in performance could be attributed to underlying difference in mental abilities. Finally, the aptitude-treatment interaction model suggested that the situation and individual

difference and their interaction were all important, concluding that some students learned better in a structured format with lectures, while other students learned better through independent study.

Biggs and Kirby (1983) suggested, however, that even the aptitude-treatment interaction model is inadequate to explain research results. They proposed that the model required the addition of what they called intervening variables which link stable individual differences to the learning task. These intervening variables are more situation-specific than the individual difference variables and Biggs and Kirby proposed that they consist of motives and strategies which the student brings to bear upon the learning task. This indicates that learners play an active role in determining what they will learn and how they will learn it, and marks a shift to an experiential or phenomenological perspective in which learning is defined by the individuals engaged in learning (Schmeck, 1988). The situation and individual differences provide the context in which the learner makes decisions about the task. This idea that students make decisions about what they will learn and choose strategies for learning implies that they will also allocate resources to achieve those strategies.

Biggs (1987b) pointed out that the effect of approaches to learning scales "on examination performance are modified by personality characteristics, and by the congruence between motives and strategies. This evidence implicates a form of *metacognition* in student learning here called metalearning" (p. 2). Biggs (1987a) shows that the metacognitive issue has two aspects: students' awareness of their motives and their ability to control those strategies. He also writes: "the extent to which students do behave metacognitively is reflected in the congruence of the strategies they choose with

their motivation state" **(**p**.** 75). Moreover, Entwistle and Entwistle (1992) declared that the theoretical framework for student approaches to study described as deep and surface approaches to learning is based on cognitive processes, described by psychologists as rote and meaningful learning (Ausubel, Novak & Hanesian, 1978).

In general terms, metacognition refers to monitoring of an individual's own memory, comprehension, and other cognitive enterprises (Flavell, 1979). Biggs (1993) defines metacognitive as "the skills associated with a learner's awareness of his or her own thinking". Wittrock (1986) also indicated that the definition of metacognition is a broad and loosely defined one that is related to the student learning process. According to Costa (1991), metacognition is a way of exploring our ability to select and design appropriate strategies for predicting information needed to solve a problem. In this variant version of Biggs' 3P model, students' perceptions of the teaching contexts are seen to be an interaction between their previous experiences of learning and the teaching context itself. When a student encounters a new teaching context, he processes them in his mind, and these processes will depend on the student's perception of the teaching context. If the new information does not make sense for the learner, his perception of the teaching will be bad. Consequently, the learner will try very hard to memorize the information, in what is called rote memory or a surface approach. The motivation here is to memorize the new information for an exam, and how to memorize the information is the strategic practice. In contrast, if the new information makes sense for the learner, his perception of the teaching will be good. Consequently, the learner will use a meaningful learning process to learn the new information or a deep approach.

Academically, students are encouraged to use deep learning approaches to learn a body of concepts, principles and events. Some students approach learning by memorization so as to use it on a test. By using memorization, they might do well in exam; however, the aim of learning is not to pass a test but rather to learn to understand and transfer what has been understood for further learning or for solving problems. Ramsden (1998) suggested that educators have to be more concerned about the quality of a learner's understanding, not the quantity of information that learners have to take in.

Relation between Conceptions of Learning and Approaches to Learning

Students' beliefs about learning and their knowledge of their own learning play an important role in shaping how they approach learning in general. Conceptually, the pre-sage component of the Biggs 3P model accommodates associated sources of variation explicitly in terms of students' prior experiences. The interest here lies in the observation that students differ considerably in terms of their conceptions of what "learning" is (Säljö, 1979; Marton, Dall'Alba & Beaty, 1993). The distinction is broadly between accumulative and transformative conceptions; in simple terms, information is either collected in a quantitative sense for possible future use, or internally rearranged as part of the process of constructing knowledge, developing personal meaning and thereby changing as a person (Säljö, 1979; Marton, Dall'Alba & Beaty, 1993).

It has been verified empirically that, in terms of process linkage, such conceptual differences potentially represent a valuable source of inter-individual variation (Meyer, 1995); contrasting conceptions of learning are associated with differing forms of learning behavior. Students also differ in terms of what they know about their own learning in both a declarative and structural sense (Boulton-Lewis, 1994). The "what", the "why",

and the “how” of learning are thus shaped and filtered by beliefs about, and conceptions of, what knowledge and learning are.

Säljö (1979) reported a five-category set of descriptors for conceptions of learning among the group of Swedish adult learners. In hierarchical order, the categories are: learning as the quantitative increase in knowledge; learning as memorizing; learning as acquisition of facts or principles, which can be retained and/or used in practice; learning as an abstraction of meaning; and learning as an interpretative process aimed at understanding reality. Marton, Dall’Alba, and Beaty (1993) subsequently identified the same five conceptions and added a sixth, changing as a person, which applies more particularly to adult students.

Students’ approaches to study are influenced by their conceptions of learning. Van Rossum and Schenk (1984) reported that the ideas people have about learning, the studying of a text and the content of that text are in considerable measure connected. They concluded that the first three conceptions in Säljö’s (1979) hierarchy are more commonly associated with reproductive approaches to learning tasks. Without the ability to conceive of learning as being more than a quantitative increase in knowledge, or memorizing, students will have extreme difficulty in adopting practices that lead to high quality learning. Thus, for a meaningful approach to learning to be employed, holding a conception of learning above Säljö’s (1979) third hierarchical level can be viewed almost as a prerequisite.

Students who conceive of learning a topic in a limited way, such as a quantitative increase in knowledge, or as memorizing, are likely to be those who adopt a surface approach to the learning of that topic. These students see tasks as imposed on them and

they intend to cope with these requirements but without reflection or purpose (Biggs, 1987a, b; Marton & Säljö, 1997; Ramsden, 1992). Conversely, students adopting a deep approach have a structure of awareness that is broader and more inclusive than that of students adopting a surface approach. This more complete awareness includes a wider range of interconnected aspects of understanding. They are able to bring to the foreground of their awareness more aspects that are relevant and useful in learning new things and developing new understanding. Students who have a more complete conception and who view learning as the abstraction of meaning, or use an interpretive process aimed at understanding reality, are more likely to be those who adopt a deep approach to the learning of that topic (Crawford, Gordon, Nicholas, & Prosser, 1994; Marton & Säljö, 1997; Van Rossum & Schenk, 1984). These conceptions of learning and of the subject being learned are part of a student's prior experience and may be part of a student's awareness when he or she is focusing on an approach to learning. While students do have predilections or preferences for a deep or surface approach (Biggs, 1999), those are not fixed characteristics. Their predilections may or may not be realized in practice, depending on the teaching context. The deep and surface approaches to learning describe the ways students relate to a specific teaching-learning environment.

Assessing predilections for different approaches to learning can be done using the Approaches to Study Inventory (ASI) (Entwistle & Ramsden, 1983) or the Study Process Questionnaire (SPQ) (Biggs, 1987b). The teaching environment can also be evaluated with the use of these instruments since students adapt to the expected requirements. Thus, responses to these questionnaires can provide information about the quality of a teaching-learning environment or of a learning task.

Using the Course Experience Questionnaire (CEQ), Ramsden (1992) reported five key learning environmental factors relating to students' approaches to learning: (1) good teaching, (2) clear goals, (3) appropriate workload, (4) appropriate assessment, and (5) emphasis on independence. He found that students who perceive the workload demands of a subject to be high and who perceive the nature of the assessment as encouraging recall of facts and hits of information are more likely to adopt a surface approach. A deep approach was found to be related to perceptions that there is choice in what is to be learned, that teaching is of a high quality, and that there are clear goals and standards for what is to be learned (Prosser, Hazel, Trigwell, & Lyons, 1996; Trigwell & Prosser, 1991; Trigwell, Prosser, Ramsden, & Martin, 1998). Trigwell and Prosser (1991) suggested that perceived environments that encourage deep approaches are more likely to facilitate higher quality learning than environments designed to discourage surface approaches.

Biggs (1987a) has described approaches as having a motive and strategy component with each motive-strategy combination defining a distinct approach to learning. The distinction between motive and strategy corresponds to that between intention and approach. The student's intentions largely determine the approach used, surface or deep, and the approach, in turn, determines the quality of learning outcome (Biggs, 1987a). A deep approach usually results in better academic performance. In fact, studies since the seventies have consistently shown that deeper approaches to learning are related to higher quality learning outcome (Marton & Booth, 1997; Prosser & Millar, 1989; Ramsden, 1992; Trigwell & Prosser, 1991; Van Rossum & Schenk, 1984). This relationship is not

as strong as it might be however, since some assessments often demand the reproduction of transmitted information, thereby encouraging a surface approach.

Summary

In the past, research studies exploring the teaching-learning context have been taken from a first-order research perspective. It has only been in the last 20 years that qualitative studies have been designed to investigate the teaching-learning process from a second-order perspective or from the participants' viewpoint allowing descriptions or classifications of phenomena to emerge from the data. From these studies, researchers have been able to identify and categorize an individual's experience of the teaching-learning process in its naturalistic setting. This paradigm shift in research has resulted in a new body of theory called "student learning research" and offers an explanation of what may be happening in the teaching-learning process. In addition, this new body of theory offers university teachers a way of addressing issues concerning the quality of student learning.

This chapter includes a literature review of studies related to teachers' approaches to teaching, learning styles and approaches to learning. The findings from those studies focusing on student learning have identified and related students' conceptions of learning to teacher's approaches to teaching.

Learning styles are stable and pervasive characteristics of an individual, expressed through the interaction of one's behavior and personality as one approaches a learning task. Previous studies have found that learning styles are related to student's academic achievement. Since learning styles and learning approach involve the measurements of how active a person is and are somewhat related to learning achievement, it is not

unreasonable to expect that there will be some connection between these measures under certain learning environments. Furthermore, learning styles are relatively stable learning behavior regardless of the teaching methods or content experienced (Keefe, 1987). Therefore, learning styles may be considered as a student's characteristic, one of the presage factors in Biggs' 3P model.

CHAPTER 3: METHODOLOGY

The purpose of this study was to identify and investigate college biology teachers' teaching methodologies and students' learning styles and to examine the impact of approaches to teaching and learning styles on students' approaches to learning via online instruction. In this chapter, the research methodology for the study is presented. The sample used in this study and data collection procedures are described. Together with the intervention to be employed, the research variables are elaborated upon. An explanation of the statistical procedure used in the study is provided, along with a discussion of the ways that these techniques are applied to answer the research questions.

Sample Selection

A cross-sectional design was used for this study. The target sample consisted of six teachers in five online courses in the undergraduate biology level at a community college in the southern area of Texas. This study used a convenience sample to identify the factors that contributed to students' approaches to learning. Independent variables included: a) students' learning styles, and b) teacher's approaches to teaching. The dependent variable was students' learning approaches, including deep approaches and surface approaches. Each course had 18-50 students and there were 159 potential participants. All students were not biology majors and those online biology courses were designed for non-biology major students. Students did not meet in the regular classroom at all. Thus, participants' demographic information was collected by Learner Profile (LP) and described in Chapter 4. All surveys were posted on Web sites. Teaching Approach Inventory (TAI) was filled out completely by the five of six instructors. Learner Profile, Kolb's Learning Style Inventory (LSI) and Study Process Questionnaire (SPQ) were

filled out completely by students. After completion, all surveys were collected by the researcher. No attempt was made to include any data from students not completing the surveys during the data collection phase of this study.

There are three elements required to estimate sample size needed for a study: a) significance level, b) desired power, and c) effect size (Cohen, 1988). Significance level, represented as a p value, is the risk of type I error. The standard usually is an alpha level of 0.05. Power is the probability of rejecting the null hypothesis when it is false (Cohen, 1988). A power of 0.8 is a conventional standard that corresponds to an acceptable risk of type II error. The effect size is an estimate of the magnitude or strength of the relationship between the research variables (Polit & Beck, 2003). The value of effect size can be calculated based on data from published studies on the same or similar problems. However, when there are no data that can reasonably be construed as relevant, the researcher is forced to use conventions based on whether the effect size is expected to be small (0.2), medium (0.5), or large (0.8).

In this study, the statistical significant level selected was a p value of 0.05, the desired power was 0.8 and the estimated effect size chosen for this study was 0.5. Few have studied the relationship between students' learning styles and approaches to learning. Although the relationships between approaches to teaching and approaches to learning were reported, most of them were from the instrument developers' studies. Thus, a medium effect size of 0.5 was used in this study. Using G*power software (Erdfelder, Faul & Uchner, 1996), this set of condition required 60 subjects using ANOVA as statistical test. The potential number of participants (n=159) was more than the required subjects for this study.

Data Collection Procedures

Written approvals for the study were obtained from the Center for Science and Mathematic Education committee and the Institutional Reviews Board (IRB) of The University of Texas at Austin. Approval for the study was obtained from the community college, where the study was conducted.

All the necessary data for this research were collected by the researcher through the Internet from the study participants. The researcher contacted six course teachers teaching the Internet-based biology courses in a community college in the southern area of Texas. All surveys were designed using Questionmark software and the Questionmark server was located at The University of Texas at Austin, School of Nursing. A consent form appeared in the first page of the survey site. Teachers or students needed to click "I AGREE" before entering the survey site. The six teachers were provided the online survey site address to fill out Teaching Approach Inventory at the beginning of the semester. Each student received an E-mail invitation letter and the online survey site address in the fourth week of the semester. The online survey site included the instruction and surveys of a Learner Profile, a Study Process Questionnaire and a Kolb Learning Style Inventory. Students were asked to fill out the surveys in the fifth week of the semester and to complete them in two weeks. A reminder E-mail was sent to each participant in the fifth and sixth weeks of the semester.

Instrumentation

Four instruments were used in this study. Kolb's Learning Style Inventory (LSI), Teaching Approach Inventory (TAI), Study Process Questionnaire (SPQ) and Learner Profile (LP). Permission was obtained to use Kolb's (1985) Learning style Inventory and

a copy of the survey was purchased from McBer and Company. The Kolb's Learning Style Inventory (LSI) was used to identify the learning style of each participant. A Learner Profile (LP), constructed by this researcher, was used to gather individual demographic information, computer skills and academic background from each student. Study Process Questionnaire (SPQ) (Biggs, Kember & Leung, 2001) was used to identify students' study approaches. Teaching Approach Inventory (TAI) (Prosser & Trigwell, 1999) was used to identify teachers' approaches to teaching. The permissions to use SPQ and TAI were granted by the authors with their indicated research agreement.

Kolb's Learning Style Inventory

Kolb's Learning Style Inventory (LSI) (1985) is an assessment of an individual's ability to learn experientially. It was developed in the 1970s and revised in 1985. The LSI has gained credibility as a learning style inventory with established reliability and validity (DeCiantis & Kirton, 1996). According to the technical specifications of the LSI (Kolb, 1985), "The four basic scales and two combination scores all show very good internal reliability as measured by Cronbach's alpha" (p.4). The Cronbach's alpha ranged from .73 to .83 (.82, .73, .83, and .78). Kolb's inventory has been linked to several learning variables such as instructional strategies, methods, or outcomes (Geiger, 1991; Green, Snell, & Parimanath, 1990; Sein & Robey, 1991), and vocational choice (Atkinson, Murrell, & Winters, 1990; Green & Parker, 1989; Highhouse & Doverspike, 1987).

The Learning Style Inventory (LSI) is a 12 item self-report inventory that was designed to measure adult learning styles. Participants are asked to read an item, and then rank their responses, on a scale of 1-4, to each of the 12 items on the LSI. The total of these results represent the learning characteristics of the participant: a) concrete

experience, b) reflective observation, c) abstract conceptualization, and d) active experimentation. A combination of these scores represents two points (one on the vertical and one on the horizontal axis) from which two intersecting lines can be drawn to determine the learning style quadrant of the participant. The result of the Learning Style Inventory (LSI) is to place participants into one of four learning style quadrants: Assimilator, Accommodator, Converger, or Diverger. Kolb (1976) described the Assimilator's dominant learning abilities as Abstract Conceptualization (AC) and Reflective Observation (RO). The greatest strength of the Assimilator is the ability to create theoretical models. The person excels in inductive reasoning and in assimilating disparate observations into an integrated explanation. The Assimilator, like the Converger, is less interested in people and more concerned with abstract concepts, but is less concerned with the practical use of theories. This learning style is characteristic of individuals in the basic sciences and mathematics rather than the applied sciences. In organizations, Assimilators are found most often in the research and planning departments.

Kolb (1976) characterized the Accommodator to be opposite of the learning strengths of the Assimilator. This person is best at Concrete Experience (CE) and Active Experimentation (AE). This person's greatest strength lies in doing things, carrying out plans and experiments, and involving himself in new experiences. This person tends to be more of a risk-taker than people with the other three learning styles. The Accommodator excels in situations that require him to adapt to immediate circumstances. Accommodators are quick to discard any plan that does not fit the current situation. They are intuitive and problem-solve by the trial and error method. Accommodators rely more

on the analytical skills of other people than their own. They enjoy people, but are sometimes impatient. Accommodators are often educated in practical fields, like business, and in action oriented jobs, like marketing or sales.

Kolb (1976) characterized the Converged dominant learning abilities as Abstract Conceptualization (AC) and Active Experimentation (AE). The practical application of ideas is of greatest interest to Convergers. A person with this style performs best in situations, like conventional intelligence tests, where there is a single correct answer to a question or problem. This person's knowledge is organized in such way that through deductive reasoning they can focus on specific problems. Research shows that Convergers are relatively unemotional and prefer to deal with things rather than people. They tend to have more technical interests, and choose to specialize in the physical sciences. This learning style is characteristic of many engineers.

Kolb (1976) defined the Diverger as characterized by the opposite learning strengths of the Convergers. This person is best at Concrete Experience (CE) and Reflective Observation (RO). This person's greatest strength lies in imaginative ability. This person excels in the ability to view concrete situations from many perspectives. Kolb labeled this style 'Diverger' because they are persons who perform best in situations that call for generation of ideas. Divergers tend to be interested in people and tend to be imaginative and emotional. This learning style is typical of individuals with backgrounds in the humanities and the liberal arts. Divergers tend to be interested in culture and are often drawn to jobs in personal counseling, organizational development, or personnel management.

Kolb's Learning Style Inventory (LSI) has its roots in the Kolb Theory of Experiential Learning (Kolb, 1984). It is a 12 item questionnaire that participants use to describe their learning process. Each item asks participants to rank four sentence endings, such as, 'When I learn: a) I like to deal with my feelings, b) I like to watch and listen, c) I like to think about ideas, or d) I like to be doing things. The four endings correspond to the four learning modes of concrete experience (CE, feeling), reflective observation (RO, watching), abstract conceptualization (AC, thinking), and active experimentation (AE, doing), The LSI measures the participant's emphasis on each learning style and on two combination scores. These scores indicate to what extent the participant engages in an abstract learning style over concrete (AC-CE) and an active learning style over reflective (AE-RO). When the LSI is completed, the 12 numbers in each column are added (Column A = CE, Column B = RO, Column C = AC, and Column D = AE). These raw scores are used to obtain the combination scores of AC-CE and AC-RO, which are placed on two intersecting axes. The AC/CE scores are placed on a vertical axis and the AE/RO scores are placed on a horizontal axis. A line is then drawn from the points on each axis until the lines meet. This meeting point determines the learning style that the participant's scores relate to and to what degree. For example, a score of AC-CE = 13 and AE-RO = 17 results in a learning style of Converger.

Teaching Approach Inventory

The Teaching Approach Inventory (TAI) has been developed to measure the ways teachers approach their teaching in a particular situation. It is composed of 16 items. Eight items are part of a sub-scale describing an approach which is intended to change students' conception or ways of seeing things through a focus on the student (Conceptual

change/student-focus CCSF approach). Four items refer to the motive of the approach and four to the strategy. The other eight items form a sub-scale labeled information transmission/teacher-focused approach (ITTF) with four items referring to the intentions to transmit information and four to the use of a teacher-focused strategy to achieve that intention. The two scales in Teaching Approach Inventory (TAI) represent two fundamentally different approaches to teaching identified in a phenomenographic study of university science teachers' approaches to teaching (Trigwell. et al., 1994). The two scales are defined as below:

1. Information Transmission/Teacher-Focus Approaches

This approach is one in which the teacher adopts a teacher-focused strategy, with the intention of transmission to the students information about the discipline. In this transmission, the focus is on facts and skills, but not on the relationships between them. The prior knowledge of students is not considered to be important and it is assumed that students do not need to be active in the teaching -learning process. (Trigwell & Prosser, 1996b)

2. Conceptual Change/Student-Focused Approaches

This approach is one in which teachers adopt a student-focused strategy to help their students change their world view or conceptions of the phenomena they are studying. Students are seen to have to construct their own knowledge, and so the teacher has to focus on what the students are doing in the teaching-learning situation. A student-focused strategy is assumed to be necessary because it is the students who have to re-construct their knowledge to produce a new world view or conception. The teacher understands

that he/she cannot transmit a new world view or conception to the students. (Trigwell & Prosser, 1996b).

The Teaching Approach Inventory (TAI) is a 16 item, self-reporting survey using five-point Likert-type scales. For each item the respondent is asked to indicate which of the following applies to him or her: 1 = never or only rarely true of me; 2 = sometimes true of me; 3 = true of me about half the time; 4 = frequently true of me; or 5 = always or almost always true of me. This inventory can be completed in about 20 minutes.

The development and testing of the Teaching Approach Inventory and the validation of the constructs through qualitative data were reported in Trigwell and Prosser (1996b). The original source of items for the inventory was a set of transcripts of interviews with 24 first-year science teachers. In the item review, 74 items were initially selected in six subscales and discussed by the researchers with the aim of reducing overlap. The fact validity of the items was examined with each author rating each item twice. After comparing the ratings of each item among the raters, it was decided that the items in the middle two intention sub-scales were not reliably rated by the authors, and they were rejected. This resulted in the first version of the inventory which contained 49 items and five subscales. The 49-item version was then sent to the original interviewers and asked them to identify any items they thought were problematic. After comparison to the qualitative analysis results from the transcripts, a 39-item inventory was generated. Then the 39-item inventory was sent for trial to random selected Chemistry and Physics Departments throughout Australia. The results of the analyses of the inventories were compared with the qualitative analyses done on the transcripts and the items further culled to increase the face validity of each sub-scale.

In the first administration of the inventory with 58 first year university science teachers, substantial relationships were found between the cognate subscales (Trigwell & Process, 1996b). That is, an information transmission intention is associated with a teacher-focused strategy and a conceptual change intention is associated with a students-focused strategy. The result shows large positive correlations between the cognate intention and strategy sub-scales, with all other correlations small and negative. This analysis confirms the close relationship between intention and strategy found in the studies of student learning using similar inventories.

In the original paper, Teaching Approach Inventory (TAI) has 22-items in five sub-scales. The internal consistency reliabilities, measured by the alpha coefficient, ranged from .56 to .74. A modified version of Teaching Approach Inventory (TAI), including 16-items in four sub-scales, will be used in this study (Prosser & Trigwell, 1999). Zhang (2001) uses this new version with 16 items on 76 in-service teachers from the University of Hong Kong. Cronbach's alpha coefficients for the four TAI subscales were .53 (Student-Focused/Intention), .54 (Student-Focused/Strategy), .63 (Teacher-Focused/Intention), and .50 (Teacher-Focused/Strategy). These alpha coefficients were similar in magnitude to those reported in Trigwell and Prosser's (1996b) study in which 22 items were used representing 5 subscales.

Scores for the teachers are calculated between the two orientations by summing the scores on their intention and strategy sub-scales.

Study Process Questionnaire

Biggs (1987a) designed the Study Process Questionnaire (SPQ) to assess the extent to which students at colleges or universities use different approaches to learning and the

motives and strategies comprising those approaches. Biggs (1987a) describes how he developed the SPQ and Learning Process Questionnaire (LPQ) during the last two decades. His hypothesis was that several factors such as cognitive style, personality, and values affect the way in which students go about studying as illustrated by a model of information processing (Biggs, 1969). Therefore, he developed first the Study Process Questionnaire (SPQ) to assess student learning processes in order to test his hypothesis (1976).

Biggs modified this questionnaire to be in line with the Ausubel theoretical developments of meaningful verbal learning theory (Ausubel, 1968). Biggs focuses on the motive strategy which is appropriate to university students, for example, answering 'why am I here?' and "what am I going to do about it?" as a general strategy for university study. Finally, Biggs came up with a congruence framework as described in page 11 (Figure 1.1).

Brown (1992) reviewed this instrument and said "the Study Process Questionnaire is a highly related instrument designed to assess the motives, strategies, and approaches that students use to learn and study" (p. 457). This questionnaire asks students questions to indicate whether they approach studying basically with a Surface Motive (to meet lower standards), a Deep Motive (an intrinsic interest in learning), or from an Achieving Motive (interest in composition and doing well) (Brown, 1992).

Hall (1992) also reviewed the SPQ and mentioned that Biggs (1987a) described the three motives and strategies that are likely to lead to different levels of learning. These levels are: the surface approach which is "likely to lead to the accurate but un-integrated recall of information for a brief period of time in order to meet minimal requirements.";

the deep approach which “leads to the greatest structural complexity and is motivated by a need to pursue personal interests in a particular area”; and the achieving approach which “is seen when a student is motivated to do well and employs a strategy that is likely to lead to whatever goals are necessary to achieve high grades” (p. 887).

SPQ has been introduced to large numbers of students in Australia and the United Kingdom. This instrument has not been used extensively outside these two countries (Kember & Gow, 1990). The reliability of SPQ measured by Cronbach’s methods was described in the manual and research monograph (Biggs, 1987a). The alpha coefficients ranged from .56 to .81.

There are several studies which confirm the reliability of SPQ. The most important one was mentioned in the SPQ manual that was received from three typical institutions—the Colleges of Art, Education, and Science at the University of Australia —which were selected because they represented the basic humanities and sciences and are represented in both university and advanced education sectors (Biggs 1987a). Biggs mentions these simply as normal samples. He discusses internal consistency measuring by the alpha coefficient for the SPQ which ranged from .61 to .78.

Biggs reported that, “the internal consistency data are likewise satisfactory, with the Surface Motive showing least consistency. This motive comprises both positive and negative aspects of extrinsic motivation - just doing enough work to pass and gain some sort of qualification, and fear of failing - and that double meaning is reflected in the lower alpha coefficients” (Biggs, 1987b, p. 23). When a pilot study was applied in October 1993 to 23 students who were preparing to get a certificate in science teaching at the

University of Pittsburgh to be high school teachers, the internal consistency was found to be an alpha that ranges from .65 to .82 (Biggs, 1987b).

Biggs (1987b) presents the SPQ validity in his manual and he mentions that Hattie and Watkins (1981) refer to the "factorial validity which they found to be satisfactory in supporting the validity of Biggs' model of the study process." They recommended SPQ for further use. Biggs said validity can be constructed by relating scores to other measures such as student performance. He mentions that several studies determine the validity of SPQ. Some of these studies found that students with high scores on deep and achievement approaches plan to continue their education, whereas those with high scores on a surface approach intend to leave soon after their first degree.

A study by Bolen, Wurm, and Hall (1994) assessed the factorial structure of the SPQ with 532 American university students. They concluded that the question of the factorial structure of the SPQ with American university students is strongly supported. A new version of the Study Process Questionnaire (SPQ) (Biggs, Kember, & Leung, 2001) is used in this study. It contains a 20 item self-report inventory. For each item the respondent is asked to indicate which of the following applies to him or her: A = never or only rarely true of me; B = sometimes true of me; C = true of me about half the time; D = frequently true of me; or E = always or almost always true of me. The 20 items fall into 2 scales with 10 items each: Deep Approach and Surface approach. Each scale has 2 subscales (motive and strategy), containing 5 items each. The Cronbach's alpha values are .73 for Deep Approach and .64 for Surface Approach. The subscales' reliability, determined by the Cronbach's alpha, is .62 (Deep Motive), .63 (Deep Strategy), .72 (Surface Motive) and .57 (Surface Strategy).

Learner Profile

This instrument is created to collect students' demographic information and other personal background. The items included in Learner Profile (LP) are gender, age, marital status, computer literacy, major, previous Internet class experience, parents' educational background and their last semester GPA.

Data Analysis

Three research questions were proposed in Chapter 1. Each research question will be answered by following statistics methods. The criterion/dependent variables were approaches to learning and the predictive/independent variables were teachers' approaches to teaching and students' learning styles.

A factorial design (2x4) and Pearson's correlations were used to answer research questions. Factorial designs provide not only the unique effect of each single variable, but also the interaction effects of all variables. Thus, one of the advantages that factorial designs provide over single factor design is that they allow us to test several hypotheses at the time. Two-way analysis of variance (ANOVA) was performed to answer all research questions. If there was a significant result found, a *post hoc* test was performed to find out where the significance lied.

Question 1: What is the impact of students' learning styles on students' approaches to learning in Internet-based biology courses?

To examine if students' learning styles were the factor to influence their approaches to learning, the main effect of the factorial design using a two-way analysis of variance (ANOVA) offered the answer to this question. The learning style measured by LSI was the independent variable and approaches to learning measured by SPQ was the dependent

variable. If a significant result was obtained, *post hoc* tests were performed to find out where the significance lied.

To examine the relationship of learning styles, learning perceiving style (AC-CE) and learning processing style (AE-RO) with approaches to learning, Pearson's correlations were performed.

Question 2: What is the impact of teachers' approaches to teaching on students' approaches to learning in Internet-based biology courses?

To examine the impact of the teachers' approaches to teaching on students' approaches to learning, the main effect of the factorial design using a two-way ANOVA provided the answer to whether there were any differences in student's approaches to learning between high and low conceptual change/ student-focused (CCSF) approaches to teaching and between high and low information transmission/teacher-focused (ITTF) approaches to teaching.

Question 3: What is the impact of teachers' approaches to teaching, students' learning styles, and individual characteristics on students' approaches to learning in college online biology courses?

To determine if teachers' approaches to teaching and students' learning styles have effects on students' approaches to learning for biology students taking online biology courses, a two-way ANOVA was performed to see if the influence of learning styles on students' approaches to learning depends on instructors' approaches to teaching.

Summary

A cross-sectional design was used in this study to examine the relationship between approaches to teaching and students' learning styles on students' study processes via

online instruction. A convenience sampling process was used in this study. Approaches to teaching was measured using Teaching Approach Inventory. Learning styles were measured by Kolb's Learning Style Inventory (Kolb, 1976). Students' approaches to learning was measured using Biggs' Study Process Questionnaire (SPQ). A Learner Profile was developed by the researcher and includes individual characteristics such as age, gender, marital status, computer literacy, major, previous Internet class experience, parents' educational background and last semester GPA.

A fixed model of factorial design was used to solve research questions. Descriptive statistics, Pearson correlation, and two-way ANOVA were used to analyze the data.

CHAPTER 4: RESULTS

In this chapter, the sample is described, and the results of the data analysis are presented. Statistical Package for the Social Sciences (SPSS) version 12 was used to compute and analyze data.

Description of the Sample

The subjects in this study consisted of 87 students from five online biology courses at a community college in the southern area of Texas. There were 159 potential participants who met the study criteria. Ninety-nine students completed and submitted the questionnaires and 12 students were eliminated due to incomplete or invalid data entry in the Learning Style Inventory, Learner Profile, and/or Study Process Questionnaire. A summary of participants and their return rate in each online class is presented in Table 4.1.

Table 4.1 Summary of participants and survey return rate

Class	Potential participants	Survey Return	Validated Survey
A	18	10 (55.6%)	10 (55.6%)
B	32	15 (46.9%)	14 (43.8%)
C	50	41 (83%)	33 (66%)
D	25	20 (80%)	18 (72%)
E	34	13 (38.2%)	12 (35.3%)
Total	159	99 (62.3%)	87 (54.7%)

Table 4.2 includes the summary of frequency of students' demographic factors. Of the 87 subjects, more than 80% of the students were female. Their age ranged from 19 to 51 with a mean of 28.59 years (SD=7.25). Martial status was categorized into two fields, unmarried (n=52, 60%) and married (n=35, 40%). Excepting four students without majors, students' majors were either nursing/pre-nursing (n=47, 54%) or health education (n=35, 40%). Fifty-two (60%) students had taken online courses before. Sixty-seven (77%) students' parents have college or higher degrees. The last semester GPA was reported by participants with a mean of 3.36 (SD= 0.49).

Descriptive data of participants' computer literacy is shown in Table 4.3. It measured nine computer skills on a scale ranging from 1 (I don't know how to use this skill) to 5 (I am expert to use the skill). Four skills were reported with an average 4.0 or above including Web Browser, E-mail, Word, and Instant Messenger. Presentation (PowerPoint), spreadsheet (Excel), chat room and discussion board had mean scores between 2.5 to 3.5. File Transfer Protocol (FTP) (Mean=1.84) was the lowest from the survey. Of the nine computer skills, E-mail, FTP, chat room, discussion board and instant messenger are considered as communication tools. E-mail is the most popular communication tool and mainly used for one-to-one or one-to-small group. It also serves for transferring small files to others. FTP is mainly used for transferring files between a server and clients. People usually use this tool to download files, especially large files. Chat room and discussion board are two popular functions seen in course management software such as Blackboard and WebCT. Chat room allows instructors to 'chat' with all students who log in synchronously in the online learning environment. Students can respond to the instructor

Table 4.2 Frequency of demographic factor of participants

Demographic factor	N	Percent
Age		
18-19	1	1.1%
20-29	50	57.5%
30-39	29	33.3%
40-49	7	8%
50-59	1	1.1%
Gender		
Male	14	16.1%
Female	73	83.9%
Marital Status		
Unmarried	52	59.8%
Married	35	40.2%
Major		
No major	4	4.6%
Nursing	48	55.2%
Health Science	35	40.2%
Online course taken		
Never	35	40.2%
1	22	25.3%
2	23	26.4%
3 +	7	8.1%
Parents' education		
High School and below	20	23%
College/University	43	49.4%
Graduate school	24	27.6%
GPA		
1.51-2.00	1	1.1%
2.01-2.50	6	6.9%
2.51-3.00	16	18.4%
3.01-3.50	36	41.4%
3.51-4.00	28	32.2%

Table 4.3 Summary of descriptive data of computer literacy

Skills	Mean	S.D.
Web Browser	4.59	0.74
E-Mail	4.66	0.68
FTP	1.84	1.21
Word	4.21	0.89
Presentation	3.41	1.31
Spreadsheet	2.63	1.2
Chat room	2.94	1.38
Discussion Board	2.72	1.4
Instant Messenger	3.99	1.26

or ‘chat’ with other students in the same way. Discussion board allows students to post messages or pictures anytime. The information can be reviewed by other students at different times. Instant messenger is a relatively new technology and mainly used for one-to-one or small group real-time communication.

Preliminary Analysis of Data

This section presents the results obtained from the study instruments: Teaching Approach Inventory, Learning Style Inventory, and Study Process Questionnaire. Descriptive data analysis and reliability are reported. Correlations among the major study variables are also presented.

Descriptive Data Analysis from the Study Instruments

Descriptive data for the Teaching Approach Inventory (TAI) and four subscales are summarized in Table 4.4. The mean and standard deviation of the TAI are presented.

Table 4.4 Summary of descriptive data of Teaching Approaching Inventory

Component	Mean	S.D.
CCSF- Intention*	14.4	4.34
CCSF- Strategy*	9.2	4.55
ITTF- Intention**	14	3.39
ITTF- Strategy**	14.6	2.3
CCSF- Overall*	23.6	8.08
ITTF- Overall*	28.6	4.51

*CCSF- Conceptual Change/Student-Focused
**ITTF-Information transmission/Teacher-Focused

Each item of the TAI was rated on a scale of 1 (Only rarely true for me) to 5 (Almost always true to me). The obtained total scores for CCSF-intention, CCSF-strategies, ITTF-intention, and ITTF-strategies of the TAI ranged from 8 to 16. The instructor of each class was categorized as high or low on CCSF as well as ITTF based on the mean of the instructors' scores. The number of students based on high or low CCSF and ITTF are shown in Table 4.5. Descriptive data for the Learning Style Inventory (LSI) and its two

Table 4.5. Summary of the number of students categorized by classes with different approaches to teaching

Approaches to Teaching	Students (N)	Percent (%)
CCSF*		
High	46	53%
Low	41	47%
Total	87	100%

Approaches to Teaching	Students (N)	Percent (%)
ITTF**		
High	63	72%
Low	24	28%
Total	87	100%

*CCSF-Conceptual change/student-focused
**ITTF-Information transmission/teacher-focused

domains, processing domains (AE-RO) and perceiving domains (AC-CE), are presented in Table 4.6 and Table 4.7. The number of each learning style, obtained score range, mean and standard deviation of the LSI are shown. Frequency of learning styles for each class is presented in Table 4.8.

Descriptive data for the Study Process Questionnaire (SPQ) and four subscales are summarized in Table 4.9. The mean and standard deviation of the SPQ are presented. Each item of the SPQ was rated on a scale of 1 (only rarely true for me) to 5 (Almost always true to me). The obtained total scores for each scale and subscale include deep approach, deep motive approach, deep strategy approach, surface approach, surface motive approach, and surface strategy approach. The descriptive data of SPQ for each learning style and high/low CCSF and ITTF approaches to teaching are presented in Table 4.10.

Table 4.6 Summary of descriptive data of Learning Style Inventory

Component	N	Percent (%)
Diverger	13	14.9
Assimilator	33	37.9
Converger	29	33.4
Accommodator	12	13.8
Total	87	100

Table 4.7 Summary of descriptive data of Learning Style Inventory by domains

Domain	Range	Mean	S.D.
Processing (AE-RO)	-14 to 29	4.09	10.06
Perceiving (AC-CE)	-18 to 32	7.21	8.68

Table 4.8 Summary of learning styles in each class

Class	Diverger	Assimilator	Converger	Accommodator
A	2 (20%)	5 (50%)	2(20%)	1 (10%)
B	3 (14.3%)	3 (21.4%)	7 (50%)	2 (14.3%)
C	7 (21.2%)	10 (30.3%)	10 (30.3%)	6 (18.2%)
D	2(11.1%)	8 (44.4%)	6 (33.3%)	2 (11.1%)
E	0 (0%)	7 (58.4%)	4 (33.3%)	1 (8.3%)
Total	13 (14.9%)	33 (37.9%)	29 (33.4%)	12 (13.8%)

Table 4.9: Summary of descriptive data of Study Process Questionnaire

Approaches to Learning	Range	Mean	S. D.
Deep Motive Approach	8 to 24	15.74	3.5
Deep Strategy Approach	7 to 24	15.01	3.8
Surface Motive Approach	5 to 17	10.37	3.23
Surface Strategy Approach	6 to 19	12.13	3.09
Deep Approach (Total)	17 to 47	30.97	6.69
Surface Approach (Total)	13 to 33	22.63	5.53

Reliability Analysis of the Study Instruments

The internal consistency reliability coefficients (Cronbach's alphas) for Teaching Approach Inventory (TAI) were .695 for CCSF-Intention; .663 for CCSF-Strategy; .255 for ITTF-Intention; and .025 for ITTF-Strategy (Table 4.11). A recent paper showed the reliability of the new version of TAI. The alpha coefficients were .53 for CCSF-Intention; .54 for CCSF-Strategies; .63 for ITTF-Intention; .50 for ITTF-Strategy. The alpha coefficients of the ITTF subscales were too low to use in this study. Since this version of TAI is a relatively new instrument, no study showed the alpha coefficients other than the first report (Zhang, 2001).

Table 4.10 Summary of descriptive data of Study Process Questionnaire for each learning style and approach to teaching

	N	Mean (SPQ)	S. D.
Deep Approach to Learning			
Diverger*	13	26.23	4.28
Assimilator*	33	33.12	6.92
Converger*	29	31.34	6.48
Accommodator*	12	29.25	6.31
CCSF_High**	46	27.89	4.83
CCSF_Low**	41	34.41	6.86
ITTF_High***	63	31.48	7.36
ITTF_Low***	24	29.63	4.33
Surface Approach to Learning			
Diverger*	13	26.54	6.50
Assimilator*	33	21.91	5.03
Converger*	29	22.03	5.10
Accommodator*	12	21.83	5.69
CCSF_High**	46	22.61	5.11
CCSF_Low**	41	22.66	6.04
ITTF_High***	63	23.05	5.85
ITTF_Low***	24	21.54	4.55

*Students' learning styles
**CCSF-Conceptual change/student-focused approaches to teaching
*** ITTF-Information transmission/teacher-focused approaches to teaching

Table 4.11. Reliability coefficients of the Teaching Approaching Inventory

TAI Measure	No. of Items	Alpha Coefficient
CCSF*- Intention	4	.695
CCSF*- Strategy	4	.663
ITTF**- Intention	4	.255
ITTF**- Strategy	4	.025

*CCSF- Conceptual Change/Student-Focused
**ITTF-Information transmission/Teacher-Focused

The internal consistency reliability coefficients (Cronbach's alphas) for Learning Style Inventory (LSI) ranged from .60 to .68. The alpha coefficient score was .63 for abstract conceptualization, .60 for concrete experiences, .68 for active experimentation, and .64 for reflective observation (Table 4.12). In the manuals, the Cronbach's alpha ranged from .73 to .83 (.82, .73, .83, and .78) (Kolb, 1985). The results in this study are lower than the previous study but lie within the acceptable range.

The internal consistency reliability coefficients (Cronbach's alphas) for Study Process Questionnaire (SPQ) were similar to a previous study of the new version of the questionnaire (.57 to .73). The alpha coefficients were .68 for deep approach- motive, .71 for deep approach- strategy, .70 for surface approach-motive, .61 for surface approach-strategy, .80 for deep approach, and .78 for surface approach (Table 4.13).

Table 4.12. Reliability coefficients for Learning Style Inventory

Measure	No. of Items	Alpha Coefficient
Abstract conceptualization (AC)	12	.63
Concrete experience (CE)	12	.60
Active experimentation (AE)	12	.68
Reflective observation (RO)	12	.64

Table 4.13. Reliability coefficients for Study Process Questionnaire

Measure	No. of Items	Alpha Coefficient
Deep approach-motive	5	.68
Deep approach-strategy	5	.71
Surface approach-motive	5	.75
Surface approach-strategy	5	.61

Research Questions Results

This section presents data analysis results for each research question. The significance level set for this study was 0.05. A fixed model of factorial design (two factors) was used to answer each of the research questions. Pearson's correlation was also used to answer parts of questions one and two. The dependent variables were the scores of deep approaches and surface approaches of the SPQ. The independent variables were learning styles and approaches to teaching. SPSS v.12 was used to compute and analyze the data. The results of the factorial design are shown in Table 4.14 using a two-way ANOVA subprogram. *Post hoc* tests for learning styles are presented in Table 4.15. Pearson's correlations for each approach to learning with learning style measure categories, and processing and perceiving domains are shown in Table 4.16.

Table 4.14. Main and interactive effects of learning styles and approaches to teaching in approaches to learning

Independent variable	Dependent variable	df	F	Sig.
LSI	Deep	3	3.91	.01(*)
	Surface	3	3.27	.03(*)
CCSF	Deep	1	11.91	<.01(*)
	Surface	1	.00	.96
LSI*CCSF	Deep	3	1.81	.153
	Surface	3	1.91	.135

* the mean difference is significant at the .05 level

Table 4.15. *Post Hoc* tests of learning styles on approaches to learning

Approaches to learning	LSI (I)**	LSI (J)**	Mean difference (I-J)	Sig.
Deep approaches to learning	1	2	-6.89(*)	<.01
		3	-5.11(*)	.04
		4	-3.02	.53
	2	1	6.89(*)	<.01
		3	5.11(*)	.59
		4	1.78	.18
	3	1	5.11(*)	.04
		2	-1.78	.59
		4	2.10	.69
	4	1	3.02	.53
		2	-3.87	.18
		3	-2.09	.69
Surface approaches to learning	1	2	4.63(*)	.04
		3	4.5	.06
		4	4.71	.13
	2	1	-4.63(*)	.04
		3	-.13	1.00
		4	.08	1.00
	3	1	-4.50	.06
		2	-.12	1.00
		4	.20	1.00
	4	1	-4.71	.13
		2	-.08	1.00
		3	-.20	1.00

Method: Tukey HSD
* the mean difference is significant at the .05 level
**1= Diverger; 2= Assimilator; 3= Converger; 4= Accommodator

Table 4.16. Correlation between learning styles and approaches to learning

LSI Component		Deep approaches	Surface approaches
CE	Correlation Coefficient	-.042	.102
	Sig. (two tails)	.701	.347
RO	Correlation Coefficient	-.145	.072
	Sig. (two tails)	.180	.507
AC	Correlation Coefficient	.382(*)	.011
	Sig. (two tails)	.000	.922
AE	Correlation Coefficient	-.057	-.105
	Sig. (two tails)	.602	.332
AE-RO	Correlation Coefficient	.045	-.071
	Sig. (two tails)	.680	.516
AC-CE	Correlation Coefficient	.287(*)	-.077
	Sig. (two tails)	.007	.479

* Correlation is significant at the 0.05 level (2-tailed).

Research Question 1: What is the impact of students' learning styles on students' approaches to learning in college online biology courses?

The results from the two-way analysis of variance (ANOVA) and Pearson's correlations were used to answer this question. Since there are no significant results in interaction effects in two-way ANOVA, the main effects will explain as if in one-way ANOVA tests. The results showed that there were significant differences among four learning styles in deep approaches to learning, $F(3, 79)= 3.91$, $p=.01$, and in surface approaches to learning, $F(3, 79)= 3.27$, $p=.03$ (Table 4.14). *Post hoc* tests were employed to determine which styles were different from the others. As shown in Table 4.15, the mean of deep approach to learning between Assimilators and Divergers (Mean difference=6.89, $p<.01$), and between Convergers and Divergers (Mean difference=5.11, $p=.04$) were significantly different. That is, Assimilators were more likely to adopt deep approaches to learning than Divergers did in the online biology courses. Convergers were more likely to adopt deep approaches to learning than Divergers did in the online biology courses as well. The mean of surface approach to learning between Divergers and Assimilators (Mean difference= 4.63; $p= .046$) was significantly different. That is, Divergers adopted more surface approaches to learning than did Assimilators in the online biology courses. In Table 4.16, Pearson's correlation showed there was a positive relationship between deep learning approaches and abstract conceptualization styles. That is, students using more abstract conceptualization styles are more likely to adopt deep approaches to learning. In other words, students perceiving information through abstractness were more likely to adopt deep approaches to learning than did those perceiving information through concrete experiences in the online biology courses.

Research Question 2: What is the impact of teachers' approaches to teaching on students' approaches to learning in college online biology courses?

Since there are no significant results in interaction effects in two-way ANOVA, the main effects will explain as if in one-way ANOVA tests. The results from the two-way ANOVA showed that there was a significant difference in deep approaches to learning between low CCSF approaches to teaching (Mean=34.41, SD=6.86) and high CCSF approaches to teaching (Mean=27.89, SD=4.83), $F(1, 79)=11.91$, $p<.01$ (Table 4.14). The mean of deep approaches to learning in low CCSF approaches to teaching are greater than ones in high CCSF approaches to teaching. That is, instructors using less conceptual change/student-focused approaches to teaching encouraged students to adopt deep approaches to learning. This result was discrepancy with previous studies in which instructors using more CCSF approaches to teaching encouraged students to adopt deep approaches to learning (Prosser & Trigwell, 1999).

Research Question 3: What is the impact of teachers' approaches to teaching and students' learning styles on students' approaches to learning in college online biology courses?

Factorial designs can show the main effect of each independent variable and the interaction of all independent variables. The results for the interaction of approaches to teaching and learning styles on approaches to learning are shown in Table 4.14. No significant F scores were obtained in either deep approaches to learning, $F(3, 79)=1.81$, $p=.153$ or surface approaches to learning, $F(3, 79)=.191$, $p=.135$. That is, the differences in deep and surface approaches to learning among four learning styles do not depend on instructors' approaches to teaching.

Summary

The results of the study were presented in this chapter. Descriptive statistics were used to describe the characteristics of the sample. Cronbach's alpha coefficients were computed to examine the internal consistency reliabilities of the Teaching Approach Inventory (TAI), Learning Styles Inventory (LSI), and Study Process Questionnaire (SPQ). The alpha coefficients in LSI and SPQ were similar to previous studies. However, low alpha coefficients in ITTF approaches and subscales in TAI were obtained and this domain was not analyzed and interpreted in this study. Factorial design with ANOVA and Pearson's correlations were performed to examine the correlations among study variables.

The research questions and the findings were as follow:

Research Question 1: What is the impact of students' learning styles on students' approaches to learning in college online biology courses?

Assimilators adopted more deep approaches to learning than did Divergers in the online biology courses. Convergers adopted more deep approaches to learning than did Divergers in the online biology courses as well. Divergers adopted more surface approaches to learning than did Assimilators in the online biology courses. Students using more abstract conceptualization styles were more likely to adopt deep approaches to learning than were those with concrete experience styles. That is, students perceiving information through abstract learning styles were more likely to adopt deep approaches to learning than were those perceiving information through concrete experience in learning style in online biology courses.

Research Question 2: What is the impact of teachers' approaches to teaching on students' approaches to learning in college online biology courses?

Instructors using conceptual change/student-focus (CCSF) approaches to teaching discouraged students to adopt deep approaches to learning. This result was discrepancy with previous studies in which instructors using CCSF approaches to teaching encouraged students to adopt deep approaches to learning.

Research Question 3: What is the impact of teachers' approaches to teaching, and students' learning styles on students' approaches to learning in college online biology courses?

No significant Fs were found in the interaction of approaches to teaching and learning styles on deep and surface approaches to learning. That is, the differences in deep and surface approaches to learning among four learning styles do not depend on instructors' approaches to teaching.

CHAPTER 5: DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents an overview of the study, discussion of study findings, and conclusions drawn from the data. Implications of the results for teaching and learning in distance education are discussed. Recommendations for future research are made.

Overview of the Study and Discussion of Study Findings

The purpose of this study was to identify and investigate college biology teachers' approaches to teaching and students' learning styles and to examine the impact of these approaches to teaching and learning styles on students' approaches to learning via Internet-based instruction. Individuals' demographic factors and computer literacy were also described. The conceptual framework for this study was based on Biggs' 3P model of teaching and learning (Biggs, 1999).

A convenience sampling technique was used. Students who met study criteria were recruited from six online biology courses at the undergraduate level of a community college in the south area of Texas. The sample consisted of 87 non-biology major students, 14 males and 73 females, with a mean age of 28.59 years.

The instruments used in the study included the Teaching Approach Inventory (TAI) (Trigwell & Prosser, 1996b), the Learning Styles Inventory (LSI) (Kolb, 1985), the Study Process Questionnaire (SPQ) (Biggs, Kember, & Leung, 2001), and the Learner Profile. Instructors' approaches to teaching were collected using the TAI. The LSI was used to categorize students' learning styles and how they perceived and processed information. Students' approaches to learning were obtained using the SPQ.

The reliability coefficients of the study instruments were calculated. For Teaching Approach Inventory, the alpha coefficients of conceptual change/student-focused (CCSF)

and information transmission/teacher-focused (ITTF) were reported by a recent study: CCSF-intention (.53), CCSF-strategy (.54), ITTF-intention (.63) and ITTF-strategy (.50) (Zhang, 2001). In this study, the alpha coefficients for CCSF subscales (CCSF-intention, .695; CCSF-strategy, .663) were higher than the recent study. The subscales of ITTF were very low, .255 for ITTF-intention and .025 for ITTF-strategy. The low subscales might result from small sample size (n=5). It also might result from the teaching-strategy differences between the online instructional design and traditional classroom settings. In addition, the instrument was originally developed from traditional classroom settings, and might not be suitable for use in online instruction. The alpha coefficients for LSI were all above .60 and close to the previous study (.82, .73, .83, and .78) (Kolb, 1985). The alpha coefficients for SPQ were all above .60 and similar to the previous study (.62, .63, .72, and .57) (Biggs, Kember, & Leung, 2001).

To answer the research questions, a factorial design was used. An analysis of variance and correlations were performed. *Post hoc* tests were employed when significant F scores were obtained by ANOVA. The results of the study are discussed.

Research question 1: What are the impacts of students' learning styles on students' approaches to learning in college online biology courses?

The results showed that there were significant differences in deep and surface approaches to learning among learning styles. *Post hoc* tests showed that Assimilators and Convergers were more likely to adopt deep approaches to learning than Divergers did in the online biology courses. In addition, Divergers were more likely to adopt surface approaches to learning than Assimilators in the online biology courses. Assimilators and Convergers have strength in perceiving information abstractly; Divergers have strength in

obtaining information through personal interactions. That is, students who have strength in thinking and perceiving information abstractly were more likely to use deep approaches to learning than those who do not have such strength. In addition, students who have strength in perceiving information through interacting with people were more likely to adopt surface approaches to learning than those who have strength in perceiving information from thinking and observing abstractly. Furthermore, the scores of abstract conceptualization (AC) and the relative amount of abstractness or concreteness in learning style (AC-CE) style had positive relationships with deep approaches to learning. In the other words, students having more strength in perceiving information abstractly were more likely to adopt deep approaches to learning in the online biology courses.

The results are not surprising. Online courses, usually having few or no face-to-face interactions, are abstract learning environments. Assimilators and Convergers who have strength in perceiving information abstractly will easily adopt online learning settings and then enhance their learning from the abstract learning environments. Divergers who prefer personal interactions to perceive information will feel bored in the online learning settings and their previous learning strategies will not work well in online courses. Since motives and strategy are two main components toward deep (meaningful) approaches to learning (Biggs, 1987a), one might speculate that their motivations will be low and their strategies will be inefficient. Therefore, Divergers were more likely to adopt surface (rote-memorizing) approaches to learning.

Few researchers have studied the relationship of approaches to learning and learning styles. Newstead (1992) used Kolb's LSI and Approaches to Study Inventory (ASI) (Entwistle & Ramsden, 1983) as tools for studying learning styles and approaches to

learning respectively to find if there was any relationship between these two scales in traditional classroom settings with 188 psychology majors. The results revealed learners having strength in perceiving information through abstractness had positive relationships with meaningful (deep) approaches to learning. Entwistle & Ramsden's results were similar to the findings in this study in that learners with more strength in perceiving information abstractly would tend to use deep approaches to learning in the online biology courses. Both studies showed the students with ability to perceive information abstractly would be more likely to adopt meaningful approaches to learning.

Research question 2: What is the impact of teachers' approaches to teaching on students' approaches to learning in the college online biology courses?

The alpha coefficients of information transmission/teacher-focused (ITTF) approaches were too low (.327). It was decided not to include them in this study. In fact, there was no significant result from ITTF when it was used as an independent variable. The results from ANOVA showed that there was a significant difference in deep approaches to learning between low conceptual change/student-focused (CCSF) approaches to teaching and high CCSF approaches to teaching. Instructors using low CCSF approaches to teaching encouraged students to adopt deep approaches to learning. This result is in contrast to the previous study (Trigwell, Prosser, & Waterhouse, 1999), in which CCSF approaches had a positive relationship with deep approaches to learning in SPQ.

The opposite result might be due to small sample size and/or the inappropriate instrument in a distance teaching environment. The previous study included 46 instructors and 3956 students (Trigwell, Prosser, & Waterhouse, 1999). In this study,

only 5 instructors and 87 students were involved. Small samples tend to produce less accurate estimates than larger samples. In other words, the larger the sample, the smaller is the sampling error. Future studies should consider having more instructors to participate. Another possibility is that the instrument was not suitable for distance teaching since it was developed using traditional classroom settings. Some teaching strategies might be limited by technologies. For example, one item in the CCSF-strategy was "In lectures for this subject, I use difficult or undefined examples to provoke debate." Debate requires interaction and discussion; although interactions are possible in online learning environments, it requires more intensive technology support from their institutes. Currently, discussion board and chat room are two of the most efficient tools for asynchronous and synchronous group interaction and discussion between instructors and students and among students. Although E-mail is a good communication tool, it does not function as efficiently as chat room or discussion board for the group-interaction purpose. From the descriptive data of computer literacy in Table 4.3, the skills of using chat room (mean=2.94, SD=1.38) and discussion board (mean=2.72, SD=1.4) were lower than E-mail skill (mean= 4.66; SD=.068) and the median, 3 (ranged 1- 5). It implied students did not use these tools much for interaction in some or all courses.

Research question 3: What is the impact of teachers' approaches to teaching, and students' learning styles on students' approaches to learning in the college online biology courses?

A factorial design can be used to analyze the interaction effect of two independent variables on dependent variables. Two-way ANOVA was used to calculate the interaction of learning styles and approaches to teaching on approaches to learning. The results for

the interaction of approaches to teaching and learning styles on approaches to learning showed no significant F scores. Thus, the differences in approaches to learning among students with different learning styles do not depend on instructors' approaches to teaching. In the other word, the impact of learning styles on students' approaches to learning was not influenced by instructors' approaches to teaching.

Conclusions

Based on the findings of this study, the following conclusions are made to refer to individuals' approaches to learning.

1. Learning styles played an import role in students' approaches to learning in the online biology courses. Online learning environments usually offer less opportunity for face-to-face interactions than traditional classrooms. Based on previous studies and Kolb's learning theory, individuals having strength in perceiving information abstractly (abstract conceptualization style) were more likely to perform better in online courses than those with concrete experience preferences (DiBartola, Miller, & Turley, 2001; Dille & Mezack, 1991; Kolb, 1984). In this study, students having strength in perceiving information abstractly (abstract conceptualization style) had a positive relationship with their deep approaches to learning. Assimilators and Convergers, both having abstract conceptualization as their dominant learning ability, were more likely to adopt deep approaches to learning than Divergers did in the online biology courses. The results indicate the individuals with the abstract conceptualization style may be more likely to

adopt deep approaches to learning than those with the concrete experience style in online learning environments.

2. The Teaching Approach Inventory (TAI) might not be suitable to measure approaches to teaching for the online biology courses. First, the answers to research question 2 showed opposite results from previous studies (Trigwell, Prosser, & Waterhouse, 1999), in which conceptual change/student-focused (CCSF) teaching strategy should encourage students to adopt deep approaches to learning. Second, small Cronbach's alpha coefficients (.255 and .025) were obtained in the information transmission/teacher-focused (ITTF) subscales. Although both results might be caused by sampling error (small sample size), it is possible that the results are due to an inappropriate instrument in the online learning environment. The Teaching Approach Inventory (TAI) was created based on traditional classroom teaching/learning studies. Although teaching approaches in traditional classroom settings should be able to transfer to an online learning environment, some strategies might be limited by technology and online teaching strategies. In the Teaching Approach Inventory, 5 of 16 items are required to have peer-to-peer and/or learner-instructor interactions. Although interactions are possible in online environments, online teaching strategies using interactions are different from those in traditional classroom settings and require advanced technology support from the institutions. Using the tools that facilitate interactions among the instructor and student might be minimized due to the refusal to try new options and/or limitations of technology in

online courses. Thus, the instructors' teaching strategies might be inconsistent with their teaching intentions due to the disuse/limitations of technology. Therefore, those inconsistent items in a single subscale were measured. The inconsistent items might result in this study's discrepant results with previous studies. In addition, low reliability coefficients were obtained because they were not measuring the true situation.

Implications for Distance Education

Instructors should understand students' learning styles and provide adapted teaching strategies for learners with different styles. In previous studies, Tan (1996) and Melara (1996) have proposed that the amount of learning will increase when the teaching style is adapted to the learner based on the learner's personality type. The hypothesis was tested and principally found to be true (Chen & Macredie, 2002; Namlu, 2003; Reed, et al., 2000). Because learners have different learning styles or a combination of styles, online educators should design activities that address their learning styles in order to provide significant experiences for each class participant. In designing online courses, this can best be accomplished by utilizing multiple instructional strategies. Small-group projects, collaborative learning, case studies, forums, etc. are good instructional strategies for online learning environments and those strategies can be designed and employed using online learning applications and tools. Instructors can provide multiple activities so learners can choose preferred learning activities.

Opportunities for interaction should be increased in online instructions to facilitate students' learning. In the Teaching Approach Inventory, approaches to teaching were categorized as information transmission/teacher-focused approaches or conceptual

change/student-focused approaches. For student-focused approaches, frequent instructor-student and student-student interactions are required in online instructional designs. Chat rooms and discussion boards are two popular tools for effective interactions. However, students had low scores on these two computer skills in this study. This might indicate that instructors did not use these two tools successfully due to either technology limitations or instructor's decisions. In addition, many contemporary courses can be characterized as Tell-&-Ask (T&A) instruction (Merrill, 2004). That is, information is presented and a few multiple-choice, true-false, or short-answer, rote-memory questions are tacked onto the end of a module or the course. This type of course is information-only and there are few interaction opportunities. If instructors do not integrate interaction strategies in their classes, students who prefer human interaction learning styles might not feel comfortable with such online courses. Thus, they would be more likely to adopt surface approaches to learning.

Recommendations for Future Research

This research attempted to identify the relationships among learning styles, approaches to teaching, and approaches to learning in an online learning environment. It also tried to provide basic knowledge to understand the influences of factors from instructors and learners to students' approaches to learning. Although some research questions have been answered, a few things relevant to this study remain that need to be studied in the future. First of all, this research should be replicated using more online courses from different departments. The results of these studies will validate the results and findings of this research, especially, the relationships of learning styles and approaches to learning. Second, the validation of TAI in online learning environments

needs to be investigated using the method of interviews and a large sample size. Technology might be the limitation for effective student-focused teaching approaches. Interviews with instructors will help to understand the relationship between teaching approaches and technology limitations. A large instructor sample size may help to determine whether the low reliability coefficients from the ITTF subscales are sampling errors. Third, replications of studies using other approaches to teaching inventories such as the Lecturer's Conceptions of Teaching and Learning Questionnaire and approaches to learning inventories such as the Approaches to Study Inventory (Entwistle & Ramsden, 1983; Gow & Kember, 1993) may clarify the low scores in ITTF subscales. Replications could better establish the relationships among teaching approaches, learners' learning styles and approaches to learning. Lastly, investigations of the relationships among other factors regarding instructors and learners and their approaches to learning will offer valuable information on how students learn. Factors other than learning styles and approaches to teaching, such as assessment methods, mode of delivery, and previous knowledge might also affect students' approaches to learning (Biggs, 1999; Ekins, 1992; Goettling, 1999; Watkins & Hattie, 1981). These findings will become a necessary grounding in establishing a desirable online learning environment, which provides meaningful individualized learning. Individualized instructions for each learner may not be an easy task; however, technological innovations and increased educational research are improving our online educational environments and attaining the goal of individualized instructions.

Summary

This chapter presented an overview of the study, discussion of study findings, and

conclusions drawn from the data. Implications for online education and recommendations for further research are made.

This dissertation reports on an empirical study that shows that different learning styles were associated with different approaches to learning in the online learning environments. In addition, different approaches to teaching by instructors were associated with students' approaches to learning in the online biology courses. Yet, the differences in approaches to learning among students with different learning styles do not depend on instructors' approaches to teaching. That is, the impact of learning styles on students' approaches to learning was not influenced by instructors' approaches to teaching.

Two conclusions are proposed. First, learning styles played important roles in students' approaches to learning in the online biology courses studied. Assimilators and Convergers were more likely to adopt deep approaches to learning than Divergers were in the online biology courses. In addition, Divergers were more likely to adopt surface approaches to learning than were Assimilators in the online biology courses. Assimilators and Convergers have strength in perceiving information abstractly; while Divergers have strength in perceiving information through face-to-face interactions. The results indicate that individuals with the ability to perceive information abstractly might be more likely to adopt deep approaches to learning than those with the ability to perceive information through concrete experience in online learning environments.

Second, the Teaching Approach Inventory might not be suitable to measure approaches to teaching for online biology courses. The result of this study showed discrepant results with previous studies (Trigwell, Prosser, & Waterhouse, 1999), in which conceptual change/student-focused (CCSF) teaching strategy should encourage

students to adopt deep approaches to learning. In addition, small Cronbach's alpha coefficients (.255 and .025) were obtained in the Information transmission/teacher-focused (ITTF) subscales. Although both results could be caused by sampling error (small sample size), some items in TAI might not be applicable to all instructors in online teaching environments due to technology limitations and instructors' decisions in interaction tools.

Implications for distance education are described based on findings and conclusions. Instructors need to better understand students' learning styles and provide adapted teaching strategies for learners with different styles. Also, opportunities for interaction should be increased in online instructions to facilitate students' learning.

Recommendations for future research include more participants from different departments, validation of the TAI in online teaching environments, and investigations of more factors (e.g., assessment methods, mode of delivery, and previous knowledge) from instructors and learners affecting approaches to learning.

APPENDICES

APPENDIX A: CONSENT FORM FOR STUDENTS

Consent Form

Title of Study: Impact of Teachers' Approaches to Teaching and Students' Learning Styles on Students' Approaches to Learning in College Online Biology Courses

You are invited to participate in a study that involves a survey designed to evaluate approaches to learning and their related factors on online biology courses. My name is Yuh-Fong Hong and I am a doctoral student at The University of Texas at Austin Science Education Center. This study is part of my dissertation work to explore teacher and learner variables affecting students' approaches to learning. You are invited to be a participant in this study because you are participating an online biology course. You may be one of 194 participants in this study.

This study has been approved by The University of Texas at Austin Institutional review Board. No deception is involved and the study involves no risk to participants. A possible benefit to you for taking part in the study is the satisfaction of providing more knowledge about your learning styles and learning process.

If you decide to participate, you will be asked to provide some personal information including age, gender, computer literacy, parents' educational background and last semester GPA. You'll also be asked to complete 3 surveys relating to demographic information, Learning Style Inventory, and Study Process Inventory. Participation in this study typically takes less than 30 minutes to complete the questionnaire and is strictly confidential. After you complete the questionnaire online, nothing else will be needed from you.

All responses are treated as confidential and in no case will responses from individual participants be identified. To ensure participants' privacy, any information that is obtained in connection with this study will be disclosed only with your permission. The results of the study will be reported as group data. Your answer on the questionnaires will not be connected to any form of academic record and activity.

You are making a decision whether or not to be in this study. If you decide to participate, please click "I AGREE" and then start the survey. Your participation in this study is completely voluntary. You have the right to withdraw from the study anytime without any penalty. There is no cost and no compensation to you for participating in this study

If you want to talk to anyone about this study because you think you have not been treated fairly or you have any other questions about this study, Please feel free to contact me or my supervising professor at the following address, email, or phone number. You keep a copy of this form for your own record.

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APPENDIX B: CONSENT FORM FOR TEACHERS

Consent Form

Title of Study: Impact of Teachers' Approaches to Teaching and Students' Learning Styles on Students' Approaches to Learning in College Online Biology Courses

You are invited to participate in a study that involves a survey designed to evaluate approaches to learning and their related factors on online biology courses. My name is Yuh-Fong Hong and I am a doctoral student at The University of Texas at Austin Science Education Center. This study is part of my dissertation work to explore teacher and learner variables affecting students' approaches to learning. You are invited to be a participant in this study because you are teaching an online biology course.

This study has been approved by The University of Texas at Austin Institutional Review Board. No deception is involved and the study involves no risk to participants. A possible benefit to you for taking part in the study is the satisfaction of providing more knowledge about your approaches to teaching and your students' learning styles and learning process.

If you decide to participate, you will be asked to complete a survey relating to approaches to teaching. Participation in this study typically takes less than 30 minutes to complete the questionnaire and is strictly confidential. After you complete the questionnaire online, nothing else will be needed from you.

All responses are treated as confidential and in no case will responses from individual participants be identified. To ensure participants' privacy, any information that is obtained in connection with this study will be disclosed only with your permission. The results of the study will be reported as group data. Your answer on the questionnaire will not be connected to any form of academic record and activity.

You are making a decision whether or not to be in this study. If you decide to participate, please click "I AGREE" and then start the survey. Your participation in this study is completely voluntary. You have the right to withdraw from the study anytime without any penalty. There is no cost and no compensation to you for participating in this study

If you want to talk to anyone about this study because you think you have not been treated fairly or you have any other questions about this study, Please feel free to contact me or my supervising professor at the following address, email, or phone number. You keep a copy of this form for your own record.

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APPENDIX C: TEACHING APPROACH INVENTORY

Teaching Approach Inventory

This inventory is designed to explore the way that academics go about teaching in a specific context or subject. This may mean that your responses to these items may be different to the responses you might make on your teaching in other contexts or subjects. Please describe the context here: _____

Please fill in the appropriate circle alongside the question number on the 'General Purpose Survey/Answer Sheet'. The letters alongside each number stand for the following response.

A—this item was *only rarely* true for me in this subject
B—this item was *sometimes* true for me in this subject
C—this item was true of me about *half the time* in this subject
D—this item was *frequently* true for me in this subject
E—this item was *almost always* true for me in this subject

Please choose the *one* most appropriate response to each question. Fill the oval on the Answer Sheet that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are CONFIDENTIAL.

1. I design my teaching in this subject with the assumption that most of the students have very little useful knowledge of the topics to be covered.

2. I feel that it is important that this subject should be completely described in terms of specific objectives relating to what students have to know for formal assessment.

3. In my class I try to develop a communication channel with students about the topics that we are studying.

4. I feel it is important to present a lot of facts in the course so that students know what they have to learn for this subject.

5. I feel that the assessment in this subject should be an opportunity for students to reveal their changed conceptual understanding of the subject.

6. I encourage peer-to-peer discussion so that students can discuss, among themselves, the difficulties that they encounter studying this subject.

7. In this subject I concentrate on covering the information that might be available from a good textbook.

8. I encourage students to restructure their existing knowledge in terms of the new way of thinking about the subject that they will develop.

9. For this subject, I use difficult or undefined examples to provoke debate.

10. I structure this subject to help students to pass the formal assessment items.

11. I think an important reason for giving lectures in this subject is to give students a good set of notes.

12. When I give this subject, I only provide the students with the information that they will need to pass the formal assessments.

13. I feel that I should know the answers to any question that students may put to me during this subject.

14. Formal teaching time is made available in this subject for students to discuss their changing understanding of the subject.

15. I feel it is better for students in this subject to generate their own notes rather than always to copy mine.

16. I feel that a lot of discussion sessions in this subject should be conducted to question students' ideas.

APPENDIX D: LEARNING STYLE INVENTORY

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APPENDIX E: STUDY PROCESS QUESTIONNAIRE

Study Process Questionnaire

This questionnaire has a number of questions about your attitudes towards your studies and your usual way of studying.

There is no *right* way of studying. It depends on what suits your own style and the course you are studying. It is accordingly important that you answer each question as honestly as you can. If you think your answer to a question would depend on the subject being studied, give the answer that would apply to the subject(s) most important to you.

Please fill in the appropriate circle alongside the question number on the 'General Purpose Survey/Answer Sheet'. The letters alongside each number stand for the following response.

A—this item is *never* or *only rarely* true of me
B—this item is *sometimes* true of me
C—this item is true of me about *half the time*
D—this item is *frequently* true of me
E—this item is *always* or *almost always* true of me

Please choose the *one* most appropriate response to each question. Fill the oval on the Answer Sheet that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are CONFIDENTIAL.

Thank you for your cooperation.

1. I find that at times studying gives me a feeling of deep personal satisfaction.

2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.

3. My aim is to pass the course while doing as little work as possible.

4. I only study seriously what's given out in class or in the course outlines.

5. I feel that virtually any topic can be highly interesting once I get into it.

6. I find most new topics interesting and often spend extra time trying to obtain more information about them.

7. I do not find my course very interesting so I keep my work to the minimum.

8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.

9. I find that studying academic topics can at times be as exciting as a good novel or movie.

10. I test myself on important topics until I understand them completely.

11. I find I can get by in most assessments by memorizing key sections rather than trying to understand them.

12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.

13. I work hard at my studies because I find the material interesting.

14. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.

15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.

16. I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.

17. I come to most classes with questions in mind that I want answering.

18. I make a point of looking at most of the suggested readings that go with the lectures.

19. I see no point in learning material which is not likely to be in the examination.

20. I find the best way to pass examinations is to try to remember answers to likely questions.

APPENDIX F: LEARNER PROFILE

Learner Profile

- Age_____

- Marital status (Please check one): 1. Single____, 2. Married_____, 3. other_____

- Major: _____

- Previous Internet courses taken (Please check one): 1. Zero course___, 2. One course___, 3. two and more courses_____

- Parents' educational background (the higher one): _____ elementary school, _____middle school, _____high school, _____college or university, _____graduate school.

- Please write down 1-5 in the following computer skill you can perform: (1, I don't know how to use the skill, 2, I know a little about the skill, 3. I know some about the skill, 4. I am good to use the skill, 5. I am a expert to use the skill)
  1. ____ E-mail and file attachment (e.g. Outlook express, Eudora)
  2. ____ Web Browsing (e.g. Internet Explorer, Netscape)
  3. ____ FTP (File Transfer Protocol) (e.g. WS-FTP, FTP through Web Browser)
  4. ____ Instant Message (e.g. AOL instance messenger, MSN messenger)
  5. ____ Word Processing (e.g. Microsoft Word, WordPerfect)
  6. ____ Presentation software (e.g. Microsoft Power point, Presentations)
  7. ____ Spread Sheet (e.g. Microsoft Excel, Quattro Pro)

- What is your last semester GPA? _____

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